R. Sheldon

August 12th 1872.

THE

NOVUM ORGANUM

Scientiarum.

IN TWO PARTS.

BY

FRANCIS BACON,

BARON VERULAM, VISCOUNT ST. ALBANS,

AND

LORD HIGH CHANCELLOR of ENGLAND.

CAREFULLY CORRECTED,

AND THE

LATIN PART TRANSLATED INTO ENGLISH,

WITH AN APPENDIX,

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ABSTRACT

OF

THE LIFE AND LABOURS

OF

LORD FRANCIS BACON,

BARON VERULAM, VISCOUNT ST. ALBANS, and LORD HIGH CHANCELLOR OF ENGLAND.

This highly dignified and distinguished character was the Son of Sir Nicholas Bacon, Lord Keeper of the Great Seal, and born at York-House, in the Strand, on the 22d of January, 1561.—Being thus descended, he was early initiated in a court life; and, as himself expresses it, both by family and education, tinged with civil affairs. — His extraordinary parts, even when a child, were so conspicuous at Court, that the Queen would often delight to talk with him, and was wont to term him her young Lord Keeper. — One saying of his she was particularly pleased with:—having asked him his age, when he was yet a boy, he answered her readily, that he was two years younger than Her Maje-ty's happy reign.—On the 16th of June, 1573, being then in his 12th year, he was entered of Trinity College. Cambridge, under Dr. John Whitgift, afterwards Archbishop of Canterbury.—Before he was full 15, he not only understood Aristotle's philosophy, but was even then come to a dislike of it, upon finding it rather contentious than useful. — At this early age, his Father called him from the University to attend into France the Queen's Ambassador, Sir Amyas Pawlet, whose esteem and confidence he gained to such a degree, that he was soon after charged by him with a commission to the Queen, which he executed with great approbation, and returned again to France to finish his travels.—During his stay in that Kingdom, his Father died, without making that separate provision for him he had intended; which, obliging him to think of some profession for a subsistance, he applied himself, more through necessity than choice, to the study of the common law, and for that purpose seated himself in Gray's Inn.—In 1597, he published his "Essays" or "Counsels," a Work, which, by displaying his uncommon skill in all the offices of civil life, proved of great service to his character.—On the 23d of July, 1603, he received the honour of Knighthood from King James. — In 1605, he published a preparative or introduction to his great Work in a Treatise "Of the Advancement and Proficiency of Learning."—In 1607, he sent his Treatise, entitled "Cogitata et visa," which was the foundation of his "Novum Organum," to Dr. Andrews, Bishop of Ely. — In 1610, he published, in Latin, another Treatise, entitled "De sapientia veterum."—In 1611, he was constituted Judge of the Marshal's Court, jointly with Sir Thomas Vavasor, then Knight-Mar-

shal. — In 1613, he succeeded Sir Henry Hobart, advanced to the place of Chief-Justice of the Common Pleas, as Attorney-General. — In 1616, he was raised to the dignity of a Privy Counsellor, whilst he was still in the office of Attorney-General:—and, as he had now more leisure from private causes, he was desirous to dedicate more time to public service; and therefore made an offer to the King of a new Digest of the Laws of England.—In 1617, upon the Chancellor's voluntary resignation of the Seals, they were given to Sir Francis Bacon, with the Title of Lord Keeper.—And in the January following, he was constituted Lord High Chancellor of England.—On the 11th of July, in the same year, he was created Baron of Verulam in Hertfordshire.— In 1621, the year following the publication of the present Work, he was publicly accused of Bribery and Corruption.—The King found it impossible to save both his Chancellor, who was openly accused of corruption, and Buckingham, his favourite, who was secretly and therefore more dangerously attacked as the encourager of whatever was deemed most illegal and oppressive: he therefore forced the former to abandon his defence, giving him positive advice to submit himself to his peers, and promising, upon his Princely word, to screen him in the last determination, or, if that could not be, to reward him afterwards with ample retribution of favour. The Chancellor, though he forefaw his approaching ruin, if he did not plead for himself, resolved to obey, and took leave of His Majesty with these words, "Those that will strike at your Chancellor, it is much to be feared, will strike at your Crown;" and wished, as he was the first, so he might be the last of sacrifices. The House of Peers, on the 3d of May, 1621, gave judgement against him, "That he should be fined 40,000*l.* and remain prisoner in the Tower during the King's pleasure; that he should for ever be incapable of any office, place, or emolument, in the State or Commonwealth; and that he should never sit in Parliament, or come within the verge of the Court." But he was soon restored to his liberty, had his fine remitted, and was summoned to the first Parliament of King Charles.—He died April 9, 1626, at the Earl of Arundel's House, at Highgate, and lies buried in St. Michael's Church, at St. Alban's, where a monument was erected for him by Sir T. Meautys, once his Secretary, and afterwards Clerk of the Council. He was of a middling stature; his forehead spacious and open, early impressed with the marks of age; his eye lively and penetrating; his whole appearance venerably pleasing. He continued single till after 40, and then took to wife a daughter of Alderman Barnham of London, with whom he received a plentiful fortune, but had by her no children; and she outlived him upwards of twenty years.—His Works, collected into five volumes, 4to. were beautifully and accurately printed by Mr. Bowyer and Mr. Strahan, in 1765.

NOVUM ORGANUM.

PART I.—SECTION I.

GENERAL APHORISMS FOR INTERPRETING NATURE, AND EXTENDING THE EMPIRE OF MAN OVER THE CREATION.

APHORISM I.

MAN, who is the servant and interpreter of nature, can act and understand no farther than he has, either in operation or in contemplation, observed of the method and order of nature.*

2. Neither the hand without instruments, nor the unassisted understanding, can do much; they both require helps to fit them for business; and, as instruments of the hand either serve to excite motion or direct it, so the instruments of the mind either suggest to, or guard and preserve, the understanding.†

3. The knowledge and power of man are coincident; for, whilst ignorant of causes, he can produce no effects: nor is nature to be conquered but by submission.‡ And that which in speculation stands for the cause, is what in practice stands for the rule.‖

4. In works, men can do no more than put natural bodies together, and take them asunder; all the rest is performed by the internal operations of nature.

* Human knowledge is acquired by observation and experience; or by conversing with the things about us, through the mediation of the senses, and subsequent reflection: therefore, the more we observe and try, the more we learn and are enabled to perform. And thus knowledge and power go hand in hand: so that the way to increase in power is to increase in knowledge. The Europeans exceed the savage Indians in power, by having a superior knowledge of arts, arms, &c. See Aph. 3.

† This Aphorism in another place is turned thus:—"The naked and unassisted hand, "however strong and true, is adapted only to the performance of a few easy works; "but, when assisted by instruments, becomes able to perform abundance more, and of "much greater difficulty: and the case is exactly the same with the mind." The whole will be abundantly explained and illustrated by what follows. See also *Introduction*, § 2 and 3.

‡ *Viz.* By condescending to inquire into and observe her methods of working; as a servant who would learn of his master. For no power of man can possibly break the chain of natural causes; so that the only method whereby man can rule nature must depend upon learning her ways.

‖ This Aphorism is otherwise expressed by the Author in another place, thus: "The human power has this for its object; to impose or introduce any nature upon a "given basis of matter, within the condition of possibility; and the object of the human knowledge is the discovery of the causes of an effect assigned, in any subject. "And these are two coincident intentions: for, what in contemplation is assigned as "the cause, is in operation the means of producing the effect." And again, thus: "There is, in fact, no difference betwixt a theoretical and practical proposition: thus "to assert that light belongs not to the nature of heat is the same as to assert, that in "the production of heat there is no necessity for the producing of light." This matter also will be fully illustrated hereafter; though it be indeed self-evident upon a little attention.

5. The mechanic, the mathematician, the physician, the Chemist, and the natural magician, are concerned in the works of nature; but all of them, at present, superficially, and to little purpose.*

6. It is madness, and a contradiction, to expect that things, which were never yet performed, should be effected, except by means hitherto untried.

7. The productions of the mind and hands seem exceedingly numerous in books and works; yet all this variety arises from the particular subtilizing upon, and applying, a few known things, and not from any number of axioms.†

8. Nay, the works hitherto discovered are owing rather to accident and trial than the sciences; which, as they now stand, are nothing but compilements of things found out before, and not methods of inquiry, or plans of new works.

9. The root of all the mischief in the sciences is this; that falsely magnifying and admiring the powers of the mind, we seek not its real helps.

10. The subtilty of nature far exceeds the subtilty of the sense and understanding; so that the sublime meditations, speculations, and reasonings, of men are but a kind of madness, if a fit person were to observe them.‡

11. As the sciences now in being are useless in the discovery of works, so is the present logic in the discovery of the sciences.

12. The common logic is better fitted to fix and establish errors, which are found in vulgar notions, than for searching after truth; so as to be more prejudicial than useful.

13. Syllogism is not applied to the principles of the sciences, and it is in vain applied to intermediate axioms,‖ as being unequal to the subtilty of nature; and therefore catches the assent, but lets things themselves slip through.§

14. Syllogism consists of propositions, propositions of words, and words are the signs of notions; therefore, if our notions, the basis

* This Aphorism is more fully delivered in another place, thus:—"The knowledge "of which mankind are hitherto possessed does not reach to certainty, and the pro- "duction of great effects. Physicians pronounce many diseases incurable, and fre- "quently mistake and fail in the cure of the rest; the alchemist never relinquishes his "hopes; the works of the natural magician are unstable, and of little advantage: the "mechanic arts derive no great light from philosophy, and but languidly prosecute ex- "periments in low and trivial subjects; so that the discoveries at present in use are "extremely crude, and far from perfect."

† Thus the numerous books wrote upon religion, laws, morality, &c. may be reduced back to a few particulars, which gave them origin; and the arts of glass, medicine, the modern art of war, &c. to the casual observation of ashes melted by heat, the accidental discovery of simples, gun-powder, &c. whereas, had all these proceeded from the light of Axioms, they would have proved much more perfect, serviceable, and advantageous: but the Axioms are wanting for this purpose.

‡ This Aphorism deserves attention. Certainly, upon examining, every man may find his common notions very inadequate, or far from corresponding even with those he gains by conversing more familiarly and intimately with nature. And yet, after a life spent upon any particular inquiry, in the common method, there still usually remains some subtilty of nature behind, which we cannot catch; and are apt, perhaps very extravagantly, to guess at. And if this be the case in sensible and material things, what must our general theories and systems be?

‖ See below, *Aph.* 19.

§ See the next Aphorism.

of all, are confused, and over hastily taken from things, nothing that is built upon them can be firm; whence our only hope rests upon genuine induction.*

15. No notion can be safely trusted, either in logics or physics; not even those of substances, qualities, actions, passions, and existence; much less those of gravity, levity, density, tenuity, moisture, dryness, generation, corruption, attraction, avoidance, element, matter, form, &c. but all are fantastical, and ill defined.†

16. The notions of the lower species, as of a man, a dog, a dove, and the immediate apprehensions of sense,‡ as heat, cold, white, black, &c. do not greatly deceive us; though these also are sometimes greatly confounded by the flowing in of matter, and the putting of things together. And for all the rest, which mankind have hitherto employed, they are mistaken, or not duly abstracted, and raised from things.‖

17. Nor is there less licentiousness, or fewer mistakes, in the raising of axioms, than in the forming of notions, and this even in principles themselves, which depend upon the vulgar Induction;§ much more in the inferior Axioms and propositions deduced by syllogism.

18. All hitherto discovered in the sciences falls nearly under vulgar notions; but to proceed farther into nature, it is requisite that both notions and Axioms be formed into things, in a surer and more guarded manner; and that a better and more certain way of working with the understanding be introduced.

19. There are two ways of searching after and discovering truth; the one, from sense and particulars, rises directly to the most general Axioms, and resting upon these principles, and their unshaken truth, finds out intermediate Axioms; and this is the method in use. But the other raises Axioms from sense and particulars, by a continued gradual ascent, till at last it arrives at the most general Axioms, which is the true way, but hitherto untried.**

20. The understanding, when left to itself, takes the first of these ways, and prepares it in logical order; for the mind delights in springing up to the most general Axioms, that it may find rest. But after

* *Viz.* A competent catalogue of instances, on both sides of the question; so that when all the exceptions are properly made, a sound, or at least a serviceable, portion of truth may be left, as an Axiom, behind. See *Aph.* 105, 106.

† Mr. Locke's Chapter of Ideas, in his Essay upon Human Understanding, is a kind of Comment upon this Aphorism.

‡ Now commonly called Sensations.

‖ See Mr. Locke's Essay upon Human Understanding.

§ The vulgar Induction, to explain it in a familiar manner, is that method of arguing which men use, when they say, *I'll give you an instance*; and then produce a case, or several cases, wherein their proposition holds. And in the same manner, the common Logical Induction proceeds upon an enumeration of particular instances, or examples; but without a due regard to those that may be produced on the contrary or negative side: so that this Induction is absolutely unsafe and trifling, as being liable to be set aside by the contradictory instances, whenever they shall appear. And this we see frequently happens, both in discourse and writing. What the Author's method of Induction is, may appear from the note upon *Aph.* 14, above; but more fully hereafter, *Aph.* 105, 106, and in the second part of this work.

** And upon this way it is that the Author rests his greatest hopes of improving philosophy and the sciences. See hereafter, *Aph.* 105.

a short stay here, it disdains experience; and these mischiefs are at length increased by logic, for the ostentation of dispute.*

21. The understanding being left to itself, in a sober, patient, and sedate genius, and especially if unprejudiced by any former doctrine, will make some attempt in the second or right way, but to little advantage; for, unless regulated and assisted, the understanding is here very unequal, and absolutely unfit to conquer the obscurity of things.

22. Both these ways begin with sense and particulars, and end in the most general principles; but they otherwise differ immensely. The one lightly passes over experience and particulars, which the other duly and orderly dwells on; the former constitutes certain abstract and useless generals from the beginning, but the latter rises gradually to such as nature really acknowledges.†

23. There is a wide difference betwixt the idols of the human mind, and the ideas of the divine mind; that is, betwixt certain vain conceits, and the real characters and impressions stamped upon the creatures, as they are found.‡

24. It is impossible that Axioms, raised by argumentation, should be useful in discovering new works, because the subtilty of nature vastly exceeds the subtilty of argument:‖ but Axioms, duly and methodically drawn from particulars, will again easily point out new particulars, and so render the sciences active.§

25. The Axioms in use, being derived from slender experience, and a few obvious particulars, are generally applied in a corresponding manner; no wonder, therefore, they lead us not to new particulars. And if any instance unobserved before happens to turn up, the Axiom is preserved by some trifling distinction, where it ought rather to be corrected.**

26. The natural human reasoning, we, for the sake of clearness, call the anticipation of nature, as being a rash and hasty thing;†† and the reason duly exercised upon objects, we call the interpretation of nature.

27. This anticipation has force enough to procure consent;‡‡ for, if all mankind were mad, in one and the same manner, they might still agree among themselves.

* There is scarcely a more pernicious thing to philosophy, than the common practice of disputing with heat, and a hasty turbulent use of syllogism. These kind of captious and sophistical contests are as the fevers of the reason.

† That is, such as men may safely proceed upon, in producing effects; for, being drawn from nature, they readily find the way to nature again, and in this sense are acknowledged by her as her own.

‡ See above, *Aph.* 10. Astronomers distinguish betwixt the real and apparent motions of the heavens; the one being respective to man, and the other to the truth; or supposing an observer seated in the centre of the system. This may, perhaps, illustrate the present Aphorism.

‖ To depend upon argumentation, or the common method of reasoning, in physical inquiries, is working only with words and thoughts, where manual operations and experiments are required.

§ See above, *Aph.* 22.

** Has not this been generally the case, from the time of Aristotle to the present?

†† See above, *Aph.* 20. See also *Introduction*, § 3.

‡‡ Is it not also the chief spring of human actions?

28. Anticipations, also, have a much greater power to entrap the assent than interpretations; because, being collected from a few familiar particulars, they immediately strike the mind, and fill the imagination; whereas interpretations, being separately collected from very various and very distant things, cannot suddenly affect the mind; whence, of necessity, in difficult and paradoxical matters, these interpretations appear almost like Mysteries of Faith.*

29. In the sciences, founded on opinion and decree, anticipations and logic are of great service, where not things, but the assent, is to be brought under subjection.

30. But, though the labours and capacities of the men in all ages were united and continued, they could make no considerable progress in the sciences, by anticipation; because, the radical errors, in the first concoction of the mind, are not to be cured by the excellence of any succeeding talents and remedies.†

31. And it is in vain to expect any great advancement of the sciences, by superinducing or engrafting new inventions upon old: the restoration must be begun from the very foundation, unless men choose to move continually in a circle, without considerably advancing.

32. All the ancient authors will still remain possessed of their honour, and unrivalled in their genius and ability; as we only point out a new path, without censuring their proceedings.

33. No true judgement can, by anticipation, be formed of this new method of ours, nor of the things it discovers; for, they cannot, in justice, be tried by the method of reasoning at present used, which is itself called in question.

34. Nor is it an easy matter to deliver, or explain, what we have to produce; because things new in themselves will still be understood from their relation to the old.‡

35. Confutations are of no service, where men differ about principles, notions, and the forms of demonstration;‖ and our desire is not victory, but only to find the minds of men prepared, and capable of receiving what we offer.

36. We have but one simple way left us, and that is, leading mankind to particulars, their senses, and their orders; whilst they prevail upon themselves to forsake their notions for a time, and begin their acquaintance with things.§

37. Our method has some resemblance with that of the Sceptics, at the entrance, but differs widely from it, and becomes opposite to it, in the end. They simply assert, that nothing is knowable, and we say, that much cannot be known of nature, in the common way; but then

* This Aphorism seems capital, or almost Axiomatical; it is made great use of hereafter, and requires to be well remembered.

† Let this Aphorism be well considered; and, if found just, remembered.

‡ See hereafter, *Aph.* 109.

‖ Yet are not most Confutations of this kind?

§ The things here intended, the Author proposed to select with judgement, as they should appear most useful in themselves, fittest for raising of Axioms, enriching the understanding, &c. and to range them in some proper order, or in the form of regular tables, that the mind might act to advantage upon them, without distraction or confusion.

they destroy the authority of the sense and understanding, whereas we supply them both with helps.*

SECTION II.

OF THE FALSE IMAGES, OR IDOLS, OF THE MIND.

1. The idols,† and false notions of the mind, take such root therein, and so possess it, that truth can hardly find entrance; and even when it is entered, these will again rise up, and grow troublesome, in the rebuilding of the sciences, unless men guard against them with all possible diligence.

2. There are four kinds of idols that possess the mind of man. In order to be better understood, we will assign names to them, and call the first kinds, Idols of the Tribe; the second, Idols of the Den; the third, Idols of the Market; and the fourth, Idols of the Theatre.

3. The raising of notions and Axioms by legitimate Induction,‡ is doubtless the proper remedy for removing and driving out the Idols of the mind; yet the indications of Idols‖ is a thing of great use, the doctrine of them being to the interpretation of nature what the doctrine of the confutation of sophisms is to the common logic.

4. Idols of the Tribe have their foundation in human nature, and the whole tribe or race of mankind; for, it is a false assertion, that the human sense is the measure of things, since all perceptions, both of the sense and mind, are with relation to man, and not with relation to the universe.§ But the human understanding is like an unequal mirror to the rays of things, which, mixing its own nature with the nature of things, distorts and perverts them.**

5. Idols of the Den, are the Idols of every man in particular;†† for, besides the general aberrations of human nature, we every one of us have our peculiar Den or Cavern, which refracts and corrupts the light of nature, either because every man has his respective temper, education, acquaintance, course of reading, and authorities, or because of

* This will be explained and illustrated, by a variety of examples, in the Second Part of the Work.

† The Author here seems to have made a happy choice of the word Idol, which elegantly distinguishes false science from true; as erroneous knowledge is a kind of idolatry, or a worship paid to false gods, which is only due to the true One.

‡ See above, *Aph.* 14.

‖ *Viz.* The discovery or pointing of them out.

§ Philosophers should, if possible, conceive of things as they are parts of the universe, and as they have their office and use therein; but men generally consider things only as they have some particular relation to the sense, which cannot possibly discover the systematical or cosmical qualities and uses of things.

** See above, *Aph.* 23, and hereafter, *Aph.* 45.

†† The Author, in another place, considers this kind of Idol as every man's particular dæmon, or seducing familiar; and again, he considers every man's mind as a glass, with its surface differently cut, so as differently to receive, reflect, and refract, the rays of light that fall upon it.

the differences of impressions, as they happen in a mind prejudiced or prepossessed, or in one that is calm and equal, &c. So that the human spirit, according to its disposition in individuals, is an uncertain, very disorderly, and almost accidental thing. Whence Heraclitus well observes, that men seek the sciences in the lesser worlds, and not in the great or common one.

6. There are also Idols that have their rise, as it were, from compact, and the association of mankind; which, on account of the commerce and dealings that men have with one another, we call Idols of the Market. For men associate by discourse, but words are imposed according to the capacity of the vulgar; whence a false and improper imposition of words strangely possesses the understanding. Nor do the definitions and explanations wherewith men of learning, in some cases, defend and vindicate themselves, any way repair the injury; for, words absolutely force the understanding, put all things in confusion, and lead men away to idle controversies and subtleties, without number.*

7. Lastly, there are Idols which have got into the human mind, from the different tenets of philosophers, and the perverted laws of demonstration. And these we denominate Idols of the Theatre; because, all the philosophies that have been hitherto invented or received are but as so many stage-plays, written or acted, as having shewn nothing but fictitious and theatrical worlds. Nor is this said only of the ancient or present sects and philosophies, for numberless other fables, of the like kind, may be still invented and dressed up, since quite different errors will proceed from almost the same common causes. Nor, again, do we mean it only of general philosophies, but likewise of numerous principles and Axioms of the sciences, which have prevailed through tradition, belief, and neglect. But these several kinds of Idols must be more fully and distinctly shewn, that the mind may be upon its guard against them.

8. The mind has this property, that it readily supposes a greater order and conformity in things than it finds; and, though many things in nature are singular, and extremely dissimilar, yet the mind is still imagining parallels, correspondencies, and relations between them, which have no existence. Hence the fiction, that all the celestial bodies moved in perfect circles; hence the fictitious element of fire, with its orb, was added to the three sensible elements, to make them four; and such kind of dreams. Nor does this folly prevail only in tenets, but also in simple notions.

9. When the mind is once pleased with certain things, it draws all others to consent, and go along with them; and, though the power and number of instances, that make for the contrary, are greater, yet it either attends not to them, or despises them, or else removes and rejects them, by a distinction, with a strong and pernicious prejudice to maintain the authority of its first choice unviolated. And hence, in most cases of superstition, as of astrology, dreams, omens, judgements, &c. those who find pleasure in such kind of vanities, always observe where the event answers, but slight and pass by the instances where it fails, which are much the more frequent. This mischief diffuses itself still more subtilly in philosophies and the sciences, where that which has once pleased infects and subdues all other things, though much more

* See Mr. Locke's Essay upon Human Understanding.

substantial and valuable than itself. And, though the mind were free from this delight and vanity, yet it has the peculiar and constant error of being more moved and excited by affirmatives than by negatives, whereas it should duly and equally yield to both. But, on the contrary, in the raising of true Axioms, negative instances have the greatest force.*

10. The human intellect is most moved by those things that strike and enter it all at once, so as to fill and swell the imagination; but, for the rest, it feigns and supposes them, after a certain imperceptible manner, to be like those few that possess the mind, whilst the understanding is quite slow, and unfit to pass so readily to remote and dissimilar instances, whereby axioms were tried as it were in the fire,† unless the task be imposed upon it by severe laws, and a potent authority.

11. The human understanding shoots itself out, and cannot rest; but still goes on, though to no purpose. Thus it is inconceivable there should be any bounds to the universe; yet it constantly, and, as it were, necessarily recurs, that there must be something farther. So, again, it cannot be conceived how eternity should have flowed to the present time; and there is the like subtilty as to the infinite divisibility of lines, &c. all arising from the weakness of human thought. But this impotence of the mind proves more pernicious in the discovery of causes; for, although the highest universals in nature ought to be positive things, because they are found, and cannot be made, yet the understanding, not knowing how to stop, is still desirous of greater satisfaction; and, endeavouring to stretch farther, lights upon final causes, which are plainly of the nature of man, rather than of the nature of the universe.‡ And from this fountain philosophy has been strangely corrupted. For it is as senseless and unphilosophical to expect causes in the most general cases, as not to require them in such as are subordinate.

12. The light of the understanding is not a dry or pure light, but drenched in the will and affections, and the intellect forms the sciences accordingly; for, what men desire should be true, they are most inclined to believe. The understanding, therefore, rejects things difficult, as being impatient of inquiry, things just and solid, because they limit hope, and the deeper mysteries of nature, through superstition; it rejects the light of experience, through pride and haughtiness, as disdaining the mind should be meanly and waverily employed; it excludes paradoxes, for fear of the vulgar. And thus the affections tinge and infect the understanding, numberless ways, and sometimes imperceptibly.

13. But much the greatest impediment and deviation of the understanding proceeds from the dulness, incompetency, and fallacies, of the senses; whence the things that strike the sense unjustly over-balance those that do not strike it immediately: so that contemplation usually ends with sight, and little or no observation is made of things invisible. And hence all the operations of the spirits, included in tangible bodies, all subtile organizations, and the motions of the parts, are unknown to

* As will be more fully shewn hereafter. See *Part* II. *Sect.* II.

† See above, *Sect.* I. *Aph.* 14, and hereafter, *Part* II. *Sect.* II.

‡ For, final causes are only expected to be such as satisfy the mind.

mankind; and yet, unless these are discovered and brought to light, nothing very considerable can be done in nature, with regard to works. Nay, the properties of the common air and numerous bodies of greater subtlety than that, remain almost unknown; for sense, of itself, is a weak and erroneous thing. Nor can instruments, for improving and sharpening the senses, be here of any great service, all true interpretations of nature being made by proper and apposite instances and experiments, wherein sense judges of the experiment only, and the experiment judges of nature, and the fact.

14. The understanding is, by reason of its own nature, carried on to abstraction, and fancies those things to be constant, which are wavering; but it is better to dissect nature, than to abstract her,* as was practised by the school of Democritus, which went farther into nature than any of the rest. And as matter is principally to be considered in all its schemes and organizations, so likewise are pure action, and the laws of action, or motion; but for the Aristotelian forms, they are Idols, or figments of the mind, unless we call the laws of motions, forms.†

15. And this kind of idols are what we term Idols of the Tribe, which have their origin either from—1. the uniformity of the human spirit;‡ 2. its prepossession;‖ 3. its narrowness;§ 4. its restless motion;** 5. the tincture of the affections;†† 6. the incompetency of the senses;‡‡ or, 7. the manner of the impression.‖‖.

16. Idols of the Den take their rise from the peculiar nature of every particular person, both with regard to soul and body, as also from education, custom, and accidents. This kind is various and manifold; but we will touch upon such as require the greatest caution, and have the greatest force to pollute the understanding.

17. Men are fond of particular sciences and studies, either because they believe themselves the authors and inventors thereof, or because they have bestowed much pains upon them, and principally applied themselves thereto. And such men as these, if they afterwards take to philosophy and universal contemplations, generally wrest and corrupt them with their former conceits, of which we have a signal example in Aristotle, who made his natural philosophy such an absolute slave to his logic, as rendered it contentious, and in a manner useless. The tribe of chemists, from a few experiments of the furnace, have run up a phantastical philosophy, of very small extent. And so Dr. Gilbert, after he had, with immense labour, prosecuted his magnetical studies, presently invented a philosophy agreeably to his own notion.§§

* That is, by making of experiments, rather than by contemplation, and reasoning upon notions, without the proper facts.

† This is meant of abstract forms; but for physical forms, or the essential and efficient cause of the peculiar properties of things, it is the principal design of the Second Part of the present Work to shew how they may be discovered. See *Aph.* 17, of that part.

‡ See above, *Aph.* 45. ‖ See *Aph.* 46. § See *Aph.* 47.

** See *Aph.* 48. †† See *Aph.* 49. ‡‡ See *Aph.* 50. ‖‖ See *Aph.* 51.

§§ Thus we see of later date, when Mathematicians apply to physics, medicine, chemistry, &c. they render them all mathematical; when Chemists apply to physics, medicine, &c. they render them chemical; so when Divines apply to philosophy, they often render it scriptural, &c. See below, *Aph.* 65.

18. The great and radical difference of capacities, as to philosophy and the sciences, lies here, that some are stronger and fitter to observe the differences of things, and others to observe their correspondencies. For a steady and sharp genius can fix its contemplations, and dwell and fasten upon all the subtlety of differences; whilst a sublime and ready genius perceives, and compares, the smallest and most general agreements of things. But both kinds easily fall into excess, by grasping either at the dividing scale, or shadows of things.

19. Some men of genius are wrapt up in the admiration of antiquity, others spend themselves in a fondness for novelty, and few are so tempered as to hold a mean, but either quarrel with what was justly laid down by the ancients, or despise what is justly advanced by the moderns. And this is highly prejudicial to philosophy and the sciences, as being rather an affectation of antiquity, or novelty, than any true judgement; for, truth is not to be derived from any felicity of times, which is an uncertain thing, but from the light of nature and experience, which is eternal. These affectations, therefore, are to be laid aside, and care taken that the understanding be not hurried by them into consent.*

20. To contemplate nature and bodies, in their simplicity, breaks and grinds the understanding; and, to consider them in their compositions and configurations, blunts and relaxes it, as appears plainly upon comparing the school of Leucippus and Democritus with the other philosophies. For, the former is so taken up with the particles of things, as almost to neglect their structure, while the other views the fabrication of things with such astonishment, as not to enter into the simplicity of nature. Both these contemplations, therefore, are to be taken up by turns, that the understanding may at once be rendered more piercing and capacious, and the inconveniencies above-mentioned, with the Idols thence arising, be prevented.

21. And, in this manner, let contemplative prudence proceed, in chasing and dislodging the Idols of the Den, which principally have their rise,—1. from prevalency; 2. the excess of composition and division; 3. affections for times; or, 4, from too great or too small a size of objects.† And, in general, whoever studies the nature of things, should hold for suspect whatever powerfully strikes and detains the mind, and use so much the greater caution to preserve his understanding pure and equable in such kind of tenets.

22. But none are so troublesome as the Idols of the Market, which insinuate themselves into the mind, from the association of words and terms. For, though men believe that their reason governs words, it also happens that words retort, and reflect their force upon the understanding; whence philosophy and the sciences have been rendered sophistical and unactive. Words are generally imposed according to vulgar conceptions, and divide things by lines‡ that are most apparent to the understandings of the multitude: and, when a more acute understanding or a more careful observation would remove these lines, to place them according to nature, words cry out, and forbid it. And hence it happens, that great and serious disputes of learned men fre-

* How much regard has been had to this Aphorism, in the late contests for and against the superiority of ancient and modern learning!

† See *Aph.* 54, 55, 56, 57. ‡ Differences, or distinctions.

quently terminate in controversies about words and terms, which it were better to begin with, according to the prudent method of the Mathematicians, and reduce them to order by definitions. But in natural and material things, even these definitions cannot remedy the evil; because definitions themselves consist of words, and words generate words, so that, of necesity, recourse must be had to particular instances, their series, and orders, as we shall shew, when we come to the manner of raising notions and Axioms.

23. The Idols which words impose upon the understanding are of two kinds, as being either the names of things that have no existence, or the names of things that do exist; but names confused, ill defined, and rashly and irregularly abstracted from things. Of the former kind are such as fortune, the *primum mobile*, the orbs of the planets, the element of fire, and the like figments, which arise from imaginary and false theories. For, as there are things that, through want of being observed, remain without names, so there are names coined upon phantastical conceits, and have no thing corresponding to them. Idols of this kind are dislodged by a constant rejection and repeal of theories and phantastical notions.*

24. But the other kind, raised by a wrong and unskilful abstraction, is intricate and deep rooted. For example; let us choose any word, as the word moisture, for instance, to try how far the things agree which are signified by it, and we shall find it no other than a confused mark of different actions, that are inconstant and irreducible to one another. For moisture signifies,—1. that which can easily diffuse itself round another body; 2. that which is indeterminable of itself, and cannot fix; 3. that which yields easily every way; 4. that which readily divides and scatters itself; 5. that which easily unites with itself, and collects together; 6. that which easily flows, and is easily put in motion; 7. that which readily sticks to another body, and wets it; 8. that which is easily melted, or reduced from a solid to a liquid. And, therefore, when this term comes to be published and imposed, with an exception of some of the significations, flame will be moist; with the exception of others, air is not moist; and, again, with some other exceptions, fine powders and glass are moist. Whence it easily appears that this notion is inconsiderately taken from water only, and some other common and obvious liquors, and not duly verified.†

25. There are also certain degrees of error and depravity in words. The least faulty kind is that of the names of substances, especially the lower species, which are well deduced; for the notions of chalk and clay are just, but the notion of earth inadequate. The tribe of actions is more faulty, such as generation, corruption, and alteration; but the notions of qualities, except the immediate objects of sense, are the most depraved, as gravity, levity, tenuity, density, &c. Yet some of these notions must, of necessity, be juster than others, in all the kinds, according to the number of instances that have fallen under the senses.‡

* Mr. Locke's Essay upon Human Understanding, Chap. of Words. See also hereafter, *Aph.* 64 &c.

† A language formed and verified after the manner here indicated, is greatly wanting in philosophy; and perhaps cannot be completed, till philosophy itself is perfected.

‡ Whence it is plain, that a just language cannot be formed without a competent knowledge of philosophy.

26. But for the Idols of the Theatre, they are neither innate, nor secretly insinuated into the understanding, but plainly palmed upon it, and received from fabulous theories, and the perverted laws of demonstration. To undertake a confutation of these, is by no means congruous with what we have already advanced;* for, where neither principles nor demonstrations are agreed upon, there can be no arguing. And this happens fortunately, to leave the ancients possessed of their glory; we can detract nothing from them, whilst the question is only concerning the way.† And a cripple in the right way may beat a racer in the wrong one. Nay, the fleeter and better the racer is, who has once missed his way, the farther he leaves it behind. Our method, however, of discovering the sciences, does not much depend upon subtlety and strength of genius, but lies level to almost every capacity and understanding. For, as it requires great steadiness and exercise of the hand to draw a true strait line, or a circle, by the hand alone, but little or no practice with the assistance of a ruler or compasses; so it is with our method. And although there be here no use of particular confutations, yet some notice must be taken, 1. of the sects and sorts of these theories; 2. the false colours thereof; 3. the causes of so great an infelicity; and 4. the causes of so lasting and general a consent in error; and all this, that the passage to truth may be made the easier, and the understanding the more disposed to cleanse itself, and put away its Idols.‡

SECTION III.

OF THE DIFFERENT PHILOSOPHICAL THEORIES.

1. The Idols of the Theatre, or Theories, are many, and will probably grow much more numerous;‖ for, if men had not, through many ages, been prepossessed with religion and theology, and if civil governments, but particularly monarchies, had not been averse to innovations of this kind, though but intended, so as to make it dangerous and prejudicial to the private fortunes of such as take the bent of innovating, not only by depriving them of advantages, but also by exposing them to contempt and hatred, there would, doubtless, have been numerous other sects of philosophies and theories introduced, of kin to those that, in great variety, formerly flourished among the Greeks. And these theatrical fables have this in common with dramatic pieces, that

* See above, *Aph.* 35.

† The Author is extremely apprehensive of being suspected to rival the ancients; which apprehension, if he had not well guarded against it, might have prejudiced his whole design, as indeed it in some measure did, and still continues to do, with many.

‡ Dr. Hooke has familiarized and illustrated some part of this doctrine of Idols, in his General Scheme, or Idea of the present State of Natural Philosophy. See Hooke's Posthumous Works, p. 7—11.

‖ The number of them has been great, ever since this Piece was written.

the fictitious narrative is neater, more elegant and pleasing, than the true history.*

2. In general, philosophy receives much matter from a few particulars, or else but little from many; so that, in both cases, it is founded on too narrow a basis of experience and natural history, and pronounces from too little knowledge.†

3. (1.) The rational tribe of philosophers hastily take up vulgar things from experience, without finding them to be certain, or carefully examining and weighing them; and commit all the rest of the work to thought, and the discussion of the wit.‡

4. (2.) Another kind of philosophers labour, with great diligence and accuracy, in a few experiments, and thence venture to deduce and build up philosophies; and strangely wrest every thing else to these experiments.‖

5. (3.) Lastly, there is a kind of such as mix theology, and traditions of faith and worship, with their philosophy; and the vanity of some among them has turned aside, to derive the sciences from spirits and angels;§ so that the origin of errors, and false philosophy, is of three kinds; *viz.* 1. sophistical; 2. empirical; and, 3. superstitious.**

6. We have an eminent example of the first kind in Aristotle, who corrupted natural philosophy with his logic, in forming the world of categories or predicaments, passing over the business of rarifaction and condensation with the *jejune* distinction of act and power, asserting but one proper motion to all bodies, and imposing numerous other fictions, at his own pleasure, upon the nature of things, being all along more solicitous how men might defend themselves by answers, and advance something that should be positive in words, than to come at the inward truth of nature.†† This will appear to the full, by comparing the philosophy of Aristotle with the other philosophies, that were celebrated among the Greeks. For the Homœomera of Anaxagoras, the Atoms of Leucippus and Democritus, the Heaven and Earth of Parmenides, the Enmity and Amity of Empedocles, the Resolution of Bodies into the neutral Nature of Fire, with their return to density, according to Heraclitus, all savour somewhat of natural philosophy and experience; whereas both the physics, and metaphysics, of Aristotle, speak little more than logical terms. It is true, his Books of Animals, Problems, and other pieces make frequent use of experiments; but then he had first pronounced without their assistance, and did not duly consult experience in forming his decrees and Axioms; but after he

* Thus the Cartesian philosophy is more agreeable to read than the Newtonian.

† Commonly in the way of the vulgar Induction above-mentioned, *Aph.* 17.

‡ See more of this below, *Aph.* 63.

‖ See below, *Aph.* 64.

§ Thus, in particular, chemistry and natural magic have been thought derived from angels and spirits.

** See below, *Aph.* 65.

†† As our education in Europe is chiefly Aristotelian, we should have a strict watch upon ourselves in all philosophical inquiries, writings, and discourses, that we are not led away with Aristotelian actions. It should seem as if all our common reasoning was infected with Aristotelian prejudices, so as to be affectedly logical and captious, rather than just and philosophical, or formed upon the true nature of things. See hereafter, *Aph.* 77.

had passed judgement, according to his own humour, he winds experience round, and leads her captive to his opinions. And, upon this account, he is more culpable than his modern followers, the scholastic philosophers, who meddled not with experience at all.

64. But the empirical philosophy produces opinions more deformed and monstrous than either the sophistical or the rational, as not being founded in the light of vulgar notions, (which, though slender and superficial, is yet in some sort universal,) but rests in the narrow confines and obscurity of a few experiments. Whence such a philosophy appears probable, and in a manner certain, to the men who daily converse with these experiments, and thereby deprave their imagination,* whilst to all others it seems incredible and vain. We have a notable example hereof in the chemists, and their doctrines, though the like, at this time, perhaps, is not to be found, unless in Gilbert's philosophy. Yet the caution, with regard to these philosophies, should by no means be passed over, because we foresee, and venture to foretel, that if mankind, being admonished by us, shall at length, in earnest, betake themselves to experience, and lay aside sophistical doctrines; even then, through an over eager and precipitant hurry of the understanding, and the desire it has of bounding or flying to generals and first principles, there will be great danger from these narrow philosophies,† which is an evil we ought to remedy.‡

65. But the corruption of philosophy, from the admixture of superstition and theology, is much more extensive and pernicious, either to whole bodies of philosophy, or their parts; for the understanding is as subject to the impressions of fancy, as to the impressions of vulgar notions. The disputations, or sophistical philosophies, may indeed intrap the understanding, but the superstitious, tumid, and, as it were, poetical kind, flatters and courts it more; for men have a certain pride of the understanding, as well as of the will, especially men of elevated genius.‖

We meet with an example of this kind among the Greeks, and principally in Pythagoras, though joined with a gross and burthensome superstition;§ but a more dangerous and subtile one in Plato, and his school.** The same kind of mischief likewise happens in the parts of the other philosophies; as, by introducing abstract forms, final causes, and first causes, commonly omitting those that are intermediate. And in this case the utmost caution should be used, for nothing is more

* That is, give it a bent some one particular way, as we see in those who have long applied themselves to a certain trade, the discovery of the longitude, the making of gol , the writing a certain book, or the prosecuting any one set of experiments; for thus, without a prudent change and intermixture, of studies and employments, the mind will be warped, and strangely draw foreign things to some consent with those under consideration, or else neglect and overlook whatever does not immediately regard the present view.

† Thus, though there is always some one reigning or general philosophy, yet almost every inquirer into nature has a particular lesser system formed upon his own experience. This appears remarkably in the Members of the Royal Academy of Sciences at Paris, &c.

‡ Regard is had thereto through the whole course of the Work.

‖ See below, *Aph.* 71.

§ See hereafter, *Aph.* 105.

** See below. *Aph.* 75, 76, 77, 96, 105.

pernicious than to canonize errors; and to venerate vanities should be accounted the pest of the understanding. Yet some of the moderns have so far indulged this strange levity, as to endeavour the founding of natural philosophy upon the first chapter of Genesis,* the book of Job, and other parts of sacred writ, thus seeking the dead among the living. And this vanity is so much the rather to be restrained and suppressed, as, from the wild mixture of divine things with human, arise not only phantastical philosophies, but heretical religions.† It is, therefore, of great importance, with a sober mind, to give to faith no more than the things that are faith's. And thus much for the bad authorities of philosophies, which are founded, 1, in vulgar notions; 2, scantiness of experiments; and, 3, in superstition.‡

66. We proceed next to the corrupt matter of contemplation,‖ especially in natural philosophy. The understanding is perverted by the sight of things performed in the mechanic arts, which generally alter the bodies by composition or separation;§ whence men are apt to imagine that something of the like kind happens in all natural bodies; and from this notion the figment of the elements, and their uniting to compose all natural bodies, had its rise. Again, when men contemplate nature in her freedom, they meet with different species or appearances of things, as animals, vegetables, minerals, and hence readily imagine there are in nature certain primary forms, or differences, which she endeavours to disclose or educe; whilst the other varieties proceed from some impediments and deviations of nature in her work, or from the struggle of different species, or bodies, together, and the transplantation of one into another.** The former imagination produced the notion of primary or elemental qualities, and the latter that of occult qualities, or specific virtues; both which are owing to the empty abridging of contemplations, wherein the mind resting, is kept from more solid knowledge. But physicians operate better by means of the secondary qualities, and virtues of things, such as those of attracting, repelling, attenuating, discussing, ripening, &c. and might have advanced much farther, but for that fruitless abridgement by the above-mentioned elementary qualities, and specific virtues, wherewith they corrupt the others, which are justly observed, either by reducing them to primary qualities, and their subtile and incommensurable mixtures, or by not carrying them on, with continued diligence and observation, to third and fourth qualities, but unseasonably breaking off the consideration. Nor are these, and the like quali-

* See Dr. Keil's Philosophical Examination of certain Theories of the Earth.

† This caution appears to have been too little observed by the modern philosophers.

‡ As is shewn in the preceding Aphorisms, 63, 64, 65.

‖ *Viz.* Where erroneous notions are formed of things; and applied, by the mental powers, in the building up of philosophy.

§ And hence mechanics and chemists are frequently deceived, when they suppose that nature separates and joins bodies, after the manner that men join and separate them.

** As when monsters are produced.

ties, to be inquired after only in medicines for the human body, but also in the changes of all other natural bodies.*

But it is much more prejudicial, that the *quiescent* principles, whereof things consist, should be studied and inquired into, and not the moving principles whereby they act; the former relating to discourse, but the latter to works. For those vulgar differences of motion in the common natural philosophy, such as generation, corruption, augmentation, diminution, alteration, removal, &c. are of little significancy, as meaning no more than that if a body, otherwise unmoved, be put out of its place, this is removal; but if the place and appearance remain the same, and the body be changed in quality, this is alteration; and if, from such a change, the bulk and quantity of the body do not remain the same, this is a motion of augmentation, or diminution; but if bodies are so far altered as to change both appearance and substance, and turn into others, this is generation and corruption. But these are mere popular notions, that no way enter into nature, being only the measures and periods, and not the species, of motion;† and pointing out only how far, and not by what means, things have proceeded. Nor do they intimate the appetites of bodies,‡ or the operations of their parts, but only when the motion exhibits a thing to the sense, in a gross manner, different from what it was; men there begin their distinction. Nay, when they would intimate any thing, as to the causes of motions, and raise a division from them, they idly introduce a *jejune* distinction betwixt natural and violent motion, this itself being but a mere vulgar conceit; for all violent motion is truly natural, the external efficient only setting nature otherwise at work than she was before.‖

On the other hand, if any one should observe that bodies have an appetite to touch each other, so as to prevent a vacuity or separation in the union of nature, or that bodies have an appetite of contracting themselves within their own natural dimensions, out of which, when they are either stretched or squeezed, they immediately endeavour to restore themselves, and recover their former state, or that bodies have an appetite of coming together to the masses of matter similar to them; that is, the mass of dense bodies towards the globe of the earth: these, and all such, are true physical kinds of motion. But the former are merely logical and scholastic, as will manifestly appear, by comparing the two together.

Nor is it a less misfortune, that men, in their philosophies and contemplations bestow their time in discovering and treating the ultimate principles, or last resorts of nature; whereas, all utility and power of acting, lies in the midway.§ But, generally, men cease not to abstract nature, till they arrive at potential and uninformed matter, or till they have divided her so far that they come to atoms, which things, though

* If light be required on this subject, Mr. Boyle's Inquiry into the origin of Forms and Qualities, may be advantageously consulted. See, in particular, the Abridgment of his Works, Vol. I. p. 271, 272.

† For the species of motion see hereafter, *Part* II. *Aph.* 48.

‡ *Viz.* The dispositions that bodies have to be affected and altered by each other, upon contact, mixture, &c, as the loadstone attracts iron, gold attracts quicksilver, &c.

‖ This is farther illustrated in the Second Part of the present Work.

§ This is already explained under *Aph.* 48, 557.

ever so real, make but little to the advantage of mankind.*—The understanding also is to be guarded against the excesses of philosophies, as to the yielding or withholding of assent, because such kind of excesses seems to fix, and in a manner perpetuate idols, as not allowing any opportunity for their removal.

These excesses are of two kinds,—the one belonging to such as pronounce hastily, and make the sciences positive and magisterial, the other to those who have introduced scepticism, and a vague indeterminate method of inquiry. The former of these depresses, and the latter enervates, the understanding. The philosophy of Aristotle (when, after the Turkish manner, it had slain its brother-rivals to the throne) pronounced upon every thing, suborning questions at pleasure, and dispatching them again, to shew that all was now certain and decided. And this method has also prevailed, and is in use, among the Aristotelian successors of philosophy.†

But the school of Plato introduced scepticism at first in the way of jest and irony, to oppose the ancient sophists, Protagoras, Hippias,‡ and the rest, who feared nothing so much as the appearing to doubt of any thing. But the new academy dogmatized upon scepticism, and professed it. And, though this was a fairer procedure than by pronouncing licentiously, (for they declared they meant not to confound inquiry, as Pyrrho and his followers did, but held what they pursued as probable, though not what they professed as true,) yet, when once the mind despairs of finding truth, all things languish; whence men rather turn aside to philology, agreeable conversation, discourse, and roving, than confine themselves to the severity of inquiry. But the point we constantly have before us is not to lessen the authority of the sense and intellect, and expose their imperfections, but to afford them all the helps we can.

And thus much for the several sorts of idols, which are all of them to be solemnly and for ever renounced, that the understanding may be thoroughly purged and cleared; for, the kingdom of man, which is founded in the sciences, can scarcely be entered otherwise than as the kingdom of God,—that is, in the condition of little children.‖

Corrupt demonstrations serve as the guards and defenders of the mind, logical demonstrations being generally such as subject and enslave the world to the thoughts of men, and thoughts to words.§ whereas genuine demonstrations are, potentially, sciences and philosophies themselves.** For such as are the demonstrations, or according as they were conducted well or ill, such are the doctrines and speculations that follow upon them. These demonstrations we at present use in the whole process that leads from sense and things, to axioms

* See above, *Aph.* 19, 20, 21, 22. † See hereafter, *Aph.* 71, 72.

‡ See below, *Aph.* 71.

‖ Viz. by discharging all the false complex ideas and unjust notions, enforced or imbibed through education, custom, prejudice, particular studies, or any of the causes above mentioned.

§ It must here be remembered, what was said above, that Syllogisms consist of propositions, propositions of words, &c. See *Aph.* 11, 12, 13, and again 24, 47.

** See *Aph.* 22. Demonstrations are potentially sciences and philosophies, because, as the demonstrations are just or false, so will the doctrines that follow from them be true or erroneous.

and conclusions, are fallacious and insufficient.* This process is of four kinds, and so are its errors: — 1. The impressions of the sense itself are vicious, for the sense both fails and deceives; but its failures are remedied by substitution, and its fallacies by rectification.† — 2. Notions are ill formed from the impressions of the senses, and prove indeterminate and confused, but ought to be clear and well limited.‡ 3. Induction is faulty, as inferring the principles of the sciences by simple enumeration, without duly excluding, resolving, and separating, things and natures.|| — 4. Lastly, that method of invention and proof which first raises the most general principles, then applies the intermediate axioms thereto, and tries them, is the mother of errors, and the destruction of all the sciences.§

But experience is by far the best demonstration, provided it dwell in the experiment; for, the transferring of it to other things, judged alike, is very fallacious, unless done with great exactness and regularity.— But the present method of experimenting is blind and stupid;¶ and, therefore, whilst men wander, and hold no certain course, but take advice only as things occur, they are hurried round to abundance of particulars, without advancing forward. And sometimes they are pleased, sometimes disconcerted, but always find matter of farther inquiry.** It commonly happens, that men make experiments slightly, and, as in the way of diversion, somewhat varying those already known; and, if they succeed not to their expectation, they grow sick of the attempt, and forsake it. Or, if they apply in earnest to experiments, they commonly bestow all their labour upon some one thing, as Gilbert upon the loadstone, and alchemists upon gold. But this procedure is as unskilful as it is fruitless; for no man can advantageously discover the nature of any thing in that thing itself, but the inquiry must be extended to matters that are more common.††

Again, if men do prosecute any science or doctrine, in the way of experiment, yet they generally go off to practice hastily and unpreparedly, and this not so much for the use and benefit of the practice itself, as to receive a kind of security in some new work, that they shall not fruitlessly employ themselves in others; as also, that, from a manifestation of their success, they may procure a better opinion of themselves, as to what they have in hand. And thus, like Atalanta, stooping to take up the golden fruit, they interrupt the course and lose the victory. But, in the true course of experience, and applying it to new works, we should follow the example of the divine wisdom

* See above, *Aph.* 26, 27, 28, 29.

† Viz. by means of suitable instruments and experiments. See *Aph.* 10, 18, 50. —But for assisting, rectifying, and verifying, the senses, see hereafter, *Part II. Aph.* 38, 39, 40, &c.

‡ See *Aph.* 15, 18, 19, 20, and 40. || See *Aph.* 14, 18, 19, 20, 21, 22.

§ See above, *Aph.* 19, &c.

¶ Not led by any light of knowledge or axioms, but proceeding by conjecture and at random.

** The remedy for all this is proposed in the Second Part of the Work.

†† Thus, in the inquiry after the means of prolonging life in man, the author first inquires into the ways of rendering simpler bodies durable, and endeavours to find out the requisites for that purpose,—then transfers so much as is suitable of the discovery to the human body.

and order; for, as God, in the first day of creation, made nothing but light, allowing one whole day to that work, without creating any material thing therein, so causes and true axioms are first to be drawn out from all kinds of experience, and the experiments of light and not of profit, to be investigated. For axioms, duly discovered and established, will afford plentiful harvest of practice, and draw after them whole sheaves of works.*

At present, we have only spoke of vulgar experience, as a false demonstration, but shall hereafter consider those ways of experimenting, which are no less blocked up and beset than the ways of judging. But first, we must treat of the signs that manifest the present philosophy and the sciences to be faulty, as also the causes of so strange a thing; for these are two very useful means of gently and calmly extirpating the idols of the mind, as a knowledge of the signs prepares the assent, and the explanation of the causes takes away the miracle.

SECTION IV.

OF THE SIGNS, OR CHARACTERISTICS, OF FALSE PHILOSOPHIES.

71. The sciences we possess are almost wholly derived from the Greeks; for, what the Roman, Arabian, and more modern, authors have added, is not much, or of any great weight; and also built upon the discoveries made by the Greeks. But the knowledge of the Greeks was of the professorial and disputatious kind, which is absolutely unfit for searching after truth. And hence the name of sophist was, by those who desired to pass for philosophers, contemptuously thrown upon the old rhetoricians, as Gorgius, Protagoras, Hippias, Polus, and almost the whole number, as Plato, Aristotle, Zeno, Epicurus, Theophrastus, and their successors, Chrysippus, Carneades, &c. There was only this difference betwixt them, that the former were a wandering mercenary tribe, who went from city to city, making a shew of their wisdom, and asking a reward; whilst the other were more grave and generous, who, having fixed habitations, opened their schools, and taught without fee. Yet both kinds were professorial;—they both reduced every thing to dispute; and instituted and defended certain sects and heresies of philosophy; so that their doctrines, as Dionysius sharply said of Plato, were only the talk of idle old men to raw young fellows. But the more ancient among the Greeks, as Empedocles, Anagoras, Leucippus, Democritus, Parmenides, Heraclitus, Xenophanes, Philolaus, &c. opened no schools that we hear of; (for we omit Pythagoras, as su-

* It is extremely difficult to convince the mind of this, at least so far as to make men act upon it. For philosophers do not seem greatly employed in discovering these causes, and raising these axioms, upon which a serviceable philosophy is to be founded.

perstitious,*) but applied themselves to the discovery of truth with greater severity and simplicity, or with less affectation and show;—and hence, we conceive, they made a greater progress,† only, through tract of time, their works are lost, and superseded by lighter studies, which prove more pleasing, and better suited to the vulgar capacity and affections;—time thus, like a river, bringing down to us such things as are light and tumid, but sinking those that are weighty and solid. Neither were these philosophers clear of the fault of their nation, but had too strong an ambition and vanity for building sects, and acquiring fame. But the search after truth is to be held desperate, when it turns aside to such empty things as these. The Egyptian priest judged, or rather prophecied, well of the Greeks,—that they would always be children, without antiquity of knowledge, or knowledge of antiquity;—and, indeed, they have this property of children, that they are ready at talk, but unripe for generation, their knowledge being verbal, and barren of works;—and, therefore, the characteristics of the philosophy in use among us, taken from that origin and nation, are false and deceitful.‡

72. Nor are the signs taken from the time and age of the Grecian philosophy much better than those taken from the nature of the people. For that age had but a very slender knowledge, both of times and the habitable world, which is a great defect, especially with such as place all things in experience. For they had not the history of a thousand years, that deserved the name of a history, but only fables

* In another place, the author observes of Pythagoras, that his doctrines and discoveries principally regarded the founding of a certain religious order, rather than the opening any school of philosophy; as may appear from the event, because his doctrine prevailed more in the Manichean heresy and the Mahometan superstition, than among philosophers.

† The Author, in another place, observes, that we have the works of Plato and Aristotle extant, so that we may form some tolerable judgement of their philosophies from the fountains themselves;—but, as to Pythagoras, Empedocles, Heraclitus, Anaxagoras, Democritus, Parmenides, Xenophanes, &c. the case is different, because we have only some fragments preserved of them, and receive their opinions at second hand, or from certain rumours; so that to discover their philosophies, requires greater diligence of inquiry, and soundness of judgement, to balance the loss.—Upon this the author declares, he had, with the utmost diligence and exactness, collected all that related to their opinions from Aristotle's confutations thereof, or, as they are cited by Plato and Cicero, the collections of Plutarch, the lives of Laertius, the poem of Lucretius, or wherever else he could find the least mention of them, and faithfully examined the whole.

‡ The philosophies of Plato and Aristotle are the chief of those delivered down, in any tolerable perfection, to us from the Greeks. That of Aristotle has been diligently explained and illustrated, but less pains seem taken with the Platonic philosophy. The Author observes, that Aristotle's philosophy is founded in vulgar notions, and the useless comparing of them together, so as to shew where they clash, and how they may be reconciled, whilst nothing solid can be expected from the man who made the system of the world a logical thing, and corrupted all his natural philosophy with logical terms and notions. As for Plato, the Author esteems him a man of a more sublime genius, who attempted even the discovery of forms, and used the form of induction, not only in principles, but in every thing, though after a fruitless manner, as always catching at and receiving vulgar inductions and abstract forms; so that, whoever attentively considers his writings and manner, will find he was not very solicitous about natural philosophy, only so far as might serve to keep up the name and reputation of a philosopher, and enable him to grace, or add a certain majesty, or dignity, to his civil or moral doctrines, whilst, at the same time, he corrupted nature as much by his theology as Aristotle did by his logic, and approached as near to a poet as Aristotle did to a sophist.

and rumours of antiquity; — and, for the different countries of the world, they knew but a very small part thereof, as calling all the more northern people Scythians, and all the western Celtæ, indiscriminately. They had no knowledge in Africa beyond the nearest part of Ethiopia, nor in Asia beyond the Ganges; and, for the new world, they never heard of it, nor had any certain tradition about it. Nay, they pronounced many climates and zones uninhabitable, where infinite people are found;—and, for the travels of Democritus, Plato, Pythagoras, &c. though celebrated as something considerable, they were but short, and almost within their own walls, compared with the voyages of our times into numerous parts of the new world, and the extremities of the old, whence we are supplied with a vast stock of experiments;—and, therefore, if signs are to be taken of philosophies, in the astrological manner, from the times of their generation and nativity, no great good is thence promised of the ancient.

73. But of all the philosophies, none are more certain and noble than those taken from their fruits —for fruits and the discoveries of works are as the vouchers and securities for the truth of philosophies. But from the philosophies of the Greeks, and their descents, through particular sciences, now for the space of so many years, scarcely a single experiment can be produced, tending to accommodate or improve the state of man, that may be justly attributed to the speculations and doctrines of their philosophy; — and thus much is ingenuously and prudently allowed by Celsus, that experiments in medicine were first made, and that men afterwards philosophized upon them, to find out and assign their causes, but did not, contrariwise, discover and deduce experiments from philosophy and the knowledge of causes. Whence it was no wonder the Egyptians, who bestowed divinity and consecration upon the inventors of things, had more images of brutes than of men; for brutes, by their natural instinct, have made many discoveries, whilst men, with their discourses and rational conclusion, have made few or none.

It is true, the industry of the chemists has produced some, though rather accidentally, and without design, or by varying experiments, as mechanics do, and not by the rules of art, or from theory, for the theory which they have imagined is rather hurtful than advantageous. So likewise the natural magicians have discovered a few light things, that approach to imposture; and, therefore, as it is a caution in religion, that faith be manifested by works, an admirable rule may hence be derived into philosophy, viz. that it be judged by its fruit, and held as vain, if it prove barren; and this the more, if, instead of grapes and olives, it produces the thistles and thorns of disputes and altercations.

74. Signs are also to be taken from the progress and increase of philosophies, and the sciences; for, things planted in nature will grow and enlarge, but things founded in opinion will differ and not thrive; — and, therefore, if the ancient doctrines had not been, like plants plucked up and severed from their roots, but still adhered to the womb of nature, and were fed by her, that could not have happened, which we see has happened, for these two thousand years, — the sciences still remaining where they were, and almost in the same condition, without any considerable improvement;—nay, they rather flourished most in their original authors, and afterwards declined. On the contrary, the mecha-

nic arts, which are founded in nature and the light of experience, and remaining pregnant, as it were, with spirit, so long as they continue to please, are ever upon their increase and growth, being first rude, then fashioned, and lastly polished, and perpetually improved.

75. There is another sign to be taken from the confession of the authors themselves, now followed by mankind, though this is rather a testimony of the strongest kind than strictly a sign. For, though these Authors pronounce upon things with so much confidence, yet at intervals, when they come to themselves again, they fall upon complaining of the subtility of nature, the obscurity of things, and the insufficiency of human nature; — and, if this were done in simplicity, it might deter the fearful from farther inquiry, and stir up others of a brisker and more daring genius to a farther prosecution; — but, not content to acknowledge only for themselves, they place beyond the bounds of possibility every thing that was either unknown or untried by them or their masters, and thus haughtily and in idiously pronounce things impossible to art, and bend the weakness of their own discoveries, to calumniate nature, and propagate despair. Hence proceeded the new school of the Academics, which made profession of scepticism, and condemned mankind to eternal darkness;*—hence the opinion, that physical forms, or the real difference of things, were impossible, or beyond the power of man to discover; — hence those notions as to operations, that the heat of the sun is a thing absolutely different from the heat of fire, lest men should think they might produce by fire, some things like the productions of nature;—and hence proceeds the notion, that composition only was the work of man, and mixture the work of nature, to keep men from expecting any artificial generation, of transformation of natural bodies!† And thus men are easily persuaded, by this false colour, not to risk their fortunes and their labours in things not only condemned, but already given up to despair.‡

76. We must not omit that other sign, viz. the great disagreement among the ancient philosophers, and the differences of their schools, which sufficiently shews that their way from sense to the understanding was not well guarded, whilst one and the same subject of philosophy, the nature of things, was rent and split into so many and such wild errors. And although at present the dissentions and disagreements of opinions as to first principles and entire philosophies are in a manner extinct,‖ yet such innumerable questions and controversies still remain among us, as make it plainly appear, that there is nothing fixed and

* See above, *Aph.* 67.

† The Author has a great regard to the abolishing of these false imaginations.—See the Second Part of the present Work.

‡ This seems to be a grand obstruction to the improvement of philosophy and arts, and extremely difficult to remove, as having not only men's natural indolence to struggle with, but also their artificial and learned despondency, in which sober and intelligent persons generally shew their judgement;—and hence new improvements in mechanics, medicine, &c. meet with a slow reception, by those esteemed for sobriety and judgement; and, though this slowness may often be well placed, yet, in general, it appears to proceed from a want of knowing the powers of man and nature, or from an inveterate prejudice against the possibility of doing things not done or not believed to have been done before. The following fifth and sixth sections are directly levelled at reforming this error.

‖ As chiefly agreeing in Peripatetic doctrine.

stable, either in our present philosophies, or the manner of our demonstrations.*

77. Men have an opinion of a general consent in the philosophy of Aristotle; as if, after that was once published, the more ancient philosophies ceased, and grew into disuse, and that nothing better was discovered in the succeeding ages, this being so well founded as to draw both former and latter times into it;—but the whole is a fallacy; for (1) the works of the more ancient philosophers were in being to the times of Cicero, and the following ages, till the inundation of the barbarians upon the Roman Empire, when the philosophies of Aristotle and Plato were saved from the general shipwreck of human learning, as light planks supported by the waves of time; — and (2) that alone can be justly called consent, which consists in a freedom of judgement agreeing in the same thing, after due examination; but far the greater number of those who consent in Aristotle's philosophy are enslaved to it by the prejudice and authority of others, so that it is rather an obsequiousness than a consent; but, though it were a free and general consent, yet consent ought to be so far from passing for any real authority, as to give a violent suspicion of the contrary; for, of all characteristics, that is the worst which men take from consent, in matters of the understanding, except such as concern religion and politics, which properly go by voices; for, nothing can please the many, but what strikes the imagination, or binds the understanding with the cords of vulgar notions.†—So that the thought of Phocion‡ may be justly transferred from morals to intellectuals, for men ought directly to examine themselves, wherein they have erred or done amiss, when the multitude consents and applauds them. This sign, therefore, of general consent, is one of the most unfavourable that a philosophy can have.|| And thus much for the characteristics of the philosophies and the sciences in use, whether taken (1) from their origins, (2) their fruits, (3) their progress, (4) the confessions of their own authors, or (5) from consent.§

* The uncertainty of the common demonstration might give occasion to the introducing of mathematical ones into physics; and these being the most certain, if they could be universally applied, men would then differ in philosophy as little as they do now in mathematics; but it may deserve a serious consideration, whether mathematical demonstrations, applied to matter, are suited to the purpose; or do not, like the common syllogism, let nature slip through, and leave the demonstration an empty thing.

† This aphorism requires a strict attention; and, unless the mind be thoroughly convinced of the truth and certainty thereof, the reader will, on many occasions, be apt to conceive, that, in what follows, the Author is delivering a kind of laborious learned dream, instead of a solid useful work.

‡ Phocion being once highly applauded by the multitude, turned round to his friends, and asked what absurdity he had committed.

|| Because, if the consent be general, the vulgar must also be admitted judges; and we all know what judges they are, and what the things must be that please the multitude.

§ See *Aph.* 71—77.

SECTION V.

OF THE CAUSES OF ERRORS IN PHILOSOPHIES.

78. We next proceed to the numerous and prevalent causes of errors and their continuance through so many ages, that men may no longer wonder how the things we advance have hitherto been hid from them, and this alone remain the surprize, how they should now come into any one's mind; which, however, in our judgement, is owing to a felicity, and not to any excellence of talent, so as rather to appear the product of time than the product of genius.*

And (1) so many ages, if justly considered, shrink to a small compass; for, of twenty-five centuries, wherein the memory and learning of mankind have been exercised, scarcely six can be culled out as fertile in sciences, or suitable to their improvement; for, times as well as countries have their wastes and deserts. There can be properly reckoned but three periods and revolutions of learning, — one among the Greeks, another among the Romans, and the third among ourselves, or the western nations of Europe, to each whereof scarcely two centuries can be fairly attributed. The middle ages of the world were unhappy as to any plentiful harvest of the sciences. Nor need we mention any thing either of the Arabians or the school-men; who, in the intermediate times, rather ground down the sciences by numerous treatises, than added to their weight;† and, therefore, the first cause of so little progress in knowledge is, properly, a scantiness of times well suited for it.

79. (2) A second cause of very great moment is, that, through all those ages, wherein men of genius and learning principally, or even moderately, flourished;—the smallest part of human industry has been spent upon natural philosophy, though this ought to be esteemed as the great mother of the sciences;‡ for, all the rest, if torn from this root, may, perhaps, be polished and formed for use, but can receive little increase;—and, it is manifest, after the Christian religion was received and gained ground, that much the greater part of the fine geniuses bent themselves to theology, whereto both the noblest rewards

* In reading the Author's works, this seems to be the general stumbling-stone:—How should he be able to do more than Plato, Aristotle, and all the ancients put together? Shall he only be in the right, and every body else in the wrong? Such a conceit of a man's own ability is monstrous, shocking, and intolerable. This is reasoning by anticipation, in the common way of men. But, when the fury is over, the question to be calmly considered is,—what has he done? But, to conquer prejudice, and bring the mind better prepared to consider of this question, the Author here endeavours to account for the strangeness of the thing, and to pacify and reconcile the mind before he informs it.

† As repeating the same matter over and over again, and new modelling and dividing it, without making any considerable addition thereto.

‡ Natural philosophy, that is, a knowledge of nature, appears to be the great mother of the sciences, because neither the arts of speech, logic, medicine, civil policy, morality, religion, &c. can be advantageously exercised, improved, understood, or instituted, without it, and all the mechanical arts depend upon it.

were annexed, and all kinds of assistance liberally afforded. And this study chiefly employed the third period of time amongst the Western Europeans;* the more, as learning then began to flourish, and controversies about religion to arise;—but, in the preceding age, during the second period, the principal study and labour of the philosophers among the Romans were bestowed upon morality, which, to the heathens, was instead of theology. Besides, the greatest geniuses of those times chiefly applied themselves to politics, the large extent of the Roman Empire requiring large assistance. But that time wherein natural philosophy seemed principally to flourish among the Greeks was of short duration; and, in the still earlier ages, the seven wise men, as they were called, all except Thales, applied themselves to moral philosophy and politics; and when Socrates afterwards brought down philosophy from the heavens to the earth, the study of morality prevailed still more, and turned the minds of men from natural philosophy.

Nay, that very period of time, wherein natural inquiries most prevailed, was corrupted and rendered useless by cavils and the ostentation of new opinions; and, therefore, as through these three periods natural philosophy was either greatly neglected or greatly obstructed, it is no wonder if mankind made little progress in it, whilst their minds were wholly bent another way.†

80. Add to this, that natural philosophy scarcely ever found one, among those who studied it, who gave himself wholly up thereto, especially in these latter times, unless we should here and there except a monk in his cell, or a studious gentleman at his country-seat, whence this philosophy has always been but as a passage and introduction to other things. And thus the great mother of the sciences is, with surprizing indignity, degraded to the handmaid, administering to the occasions of medicine or mathematics, and tending the unripe capacities of youth, or giving them their first tincture, for the more commodious and successful attainment of other kinds of learning.

But let none expect any great promotion of the sciences, especially in their effective part, unless natural philosophy be drawn out to particular sciences; and again, unless these particular sciences be brought back to natural philosophy. From this defect it is that astronomy, optics, music, many mechanic arts, medicine itself, and, what seems more strange, even moral and civil philosophy and logics, rise but little above their foundations, and only skim over the surfaces and varieties of things, viz. because, after these particular sciences are divided off and formed, they are no longer nourished by natural philosophy, which might give them new strength and increase, as, from the causes and genuine consideration of motions, light, sounds, the texture and structure of bodies, the affections, and intellectual apprehensions; and, therefore, no wonder if the sciences thrive not, whilst they are separated from their roots.‡

81. Another great reason of the slow progress of the sciences is this, that it is impossible to proceed well in a course where the end is not

* See Aph. 78.

† Let care be taken to verify or falsify this account from history as much as possible, wherever it be required.

‡ This coincides with Aph. 79.

rightly fixed and defined. Now the true and genuine end of the sciences is no other than to enrich human life with new inventions and new powers; but much the greater number of the sciences produce nothing in this kind, being merely hirelings and professorial, unless by accident sometimes an ingenious artificer, through desire of glory, endeavours after some new invention, which he generally pursues to his own loss, whilst the bulk of mankind are so far from proposing to enlarge the mass of arts and sciences, that they only take from the present collection, or covet so much as they can convert to the use of their profession, their own advantage, reputation, or some such narrow and inferior purpose.* But if any one of the number does ingenuously affect a science for its own sake, yet he will be found to pursue a variety of thoughts and doctrines, rather than a severe and rigid inquiry after the truth; or if any exact inquirer should turn up, yet even he will propose to himself such a measure of truth as may satisfy his own mind, in assigning the causes of things already known, and not that which may procure fresh pledges and earnests of works and new light of axioms.† Therefore, since the end of the sciences has not hitherto been fixed and defined by any one, we need not wonder if men have erred and wandered in the things subservient to the proper end.

83. Again, if this end had been rightly proposed, yet men have chose a very wrong and impassable way to proceed in;—and it may strike any one with astonishment who duly considers it, that no mortal should have hitherto taken care to open and prepare a way for the human understanding, from sense and a well-conducted experience, but that all things should be left either to the darkness of tradition, the giddy agitation and whirlwind of argument,‡ or else to the uncertain waves of accident or a vague and uninformed experience. Let any one soberly and carefully consider what that way is which men have accustomed themselves to in the inquiry and discovery of any thing, and he will doubtless find, that the manner of invention most commonly used is simple and unartful, or no other than this, viz. when a person goes upon an inquiry, in the first place he searches out and peruses what has been said upon it by others, in the next place adds his own thoughts thereto, and, lastly, with great struggle of the mind, solicits and invokes, as it were, his own spirit to deliver him oracles,‖ which is a method entirely destitute of foundation, and rolls wholly upon opinions.

Others may chance to call in the assistance of logic;—but this is only a nominal assistance, for logic does not discover the principles and capital axioms upon which arts are built,§ but such only as seem agreeable thereto; and when men are curious and earnest with it, to procure proofs and discover principles or first axioms, it refers them to

* Does not this remain the general case still?

† Let the more eminent of the modern inventors and philosophers be examined by this rule.

‡ See above, Aph. 10.

‖ This is the theoretical philosopher in his study, who writes with struggle and pains out of his own invention, instead of consulting nature and experience, which alone afford materials worth the recording.

§ See Aph. 13, 14, &c.

faith, or puts them off with this trite and common answer, that every artist must be believed in his own art.*

There remains, therefore, nothing but mere experience, which, offering itself, is called accident, but, when sought, experiment; and this kind of experience is but like loose twigs,† and a bare feeling about for the right way in the dark, whilst it were much more advisable to wait for day, or light up a flambeau, and then pursue the road.‡ On the other hand, the true method of experience first procures the light, then shews the way by its means, beginning with well-regulated and digested experiments, (not such as are wild, scattered, and rambling,) and thence deriving axioms, and again, from these axioms, well-established sets of new experiments.‖ For the divine word itself did not operate upon the mass of things without order.

Men, therefore, may cease to wonder that the sciences are no farther advanced, when they have entirely missed the way and quite forsaken experience; or else, bewildering themselves therein, have coursed about it, as in a labyrinth; for, it is a well-appointed order that must lead, in a continued path, through the thickets of experience, to the open plains of axioms.

83. This mischief has obtained a surprizing spread, from a certain opinion, or rivetted conceit, no less tumid than destructive; as if it were a diminution to the majesty of the mind to be long conversant in experiments, and such particulars as are subject to sense and confined to matter, especially as these things are usually laborious in the inquiry, ignoble in speculation, unpolite in discourse, ungenteel in the practice, infinite in number, and of little sublimity; the issue of all which is, that the true way has not only been forsaken, but also blocked up and obstructed, and experience not only deserted and ill-conducted, but disdained.§

84. Again, the reverence of antiquity and the authority of such as have borne a great reputation for philosophy, and thence the current consent, has withheld and almost chained down mankind from advancing the sciences. But of consent we have spoken above.**

* This having obtained as an almost general rule, the natural and mechanical philosophers, even of the present time, are obliged to resort to artizans, mechanics, and tradesmen, to discover their practices, and learn of the shops what works are performed by art and industry; whereas, if things were in their proper channel, all arts, inventions, and works, should flow from natural philosophers, and life owe these advantages to them which it now receives from ingenious and inventive mechanics. The consideration hereof seems to have occasioned that noble design of Mr. Boyle, to put a set of ingenious youths apprentices to several trades, in order, by their communications and discoveries afterwards, to improve the state of natural philosophy.

† Viz. according to the common expression, a broom or faggot unbound, as having little use, till reduced from their straggling state into collections of some form or order, and fit for certain purposes.

‡ In allusion to the light which the Author, in this Work, endeavours to set up.

‖ The method in doing this is shewn in the Second Part.

§ And surely, if natural philosophy has received any improvement of late, it is principally owing to the greater reputation which experience and practice have gained, and the prosecuting, with some tolerable care and order, the business of experimenting in a variety of subjects.

** See Aph. 77. See also Aph. 55.

The opinion which men entertain of antiquity is a very idle thing, and almost incongruous to the world; for, the old age and length of days of the world should, in reality, be accounted antiquity, and ought to be attributed to our own times, not to the youth of the world, which it enjoyed among the ancients; for, that age, though with respect to us it be ancient and greater, yet, with respect to the world, it was new and less; and, as we justly expect a greater knowledge of things, and a riper judgement, from a man of years than from a youth, on account of the greater experience, and the greater variety and number of things seen, heard, and thought of, by the person in years, so might much greater matters be justly expected from the present age (if it knew but its own strength, and would make trial and apply) than from former times, as this is the more advanced age of the world, and now enriched and furnished with infinite experiments and observations.*

It must also go for something, that, by means of the long voyages and travels, so famous in our times, numerous things have been procured and discovered in nature, for giving new light to philosophy; and it would be scandalous for mankind to have the tracts of the material globe, its countries, seas, and the heavens themselves, greatly laid open to the view of these times, and yet the intellectual world remain within the narrow confines of the inventions of the ancients.†

It is the greatest weakness to be attributing infinite things to authors, whilst we are refusing justice to the author of authors and all authority, which is Time; for, Truth is called the daughter of Time, not of Authority; whence it is no wonder if these joint fascinations, viz. of authors, of antiquity, and consent, should so far bind the faculties of men, as to keep them, like persons possessed, from conversing with things themselves.‡

85. And not only the admiration of antiquity, authority, and consent, has constrained the industry of men to acquiesce in things already discovered, but also an admiration of the works they have long possessed; for, when a man views that variety and beautiful apparatus of things introduced and provided by the mechanic arts for human uses, he is rather inclined to admire the opulency of mankind than entertain a sense of their want; not considering that the original observations of men and the operations of nature, which proved like the soul and first mover of all this variety, were neither numerous nor derived from any great depth of knowledge, and that the rest was owing

* Let us beware there is no defect in this argument. It is to be apprehended that many of the arts known to the ancients are now lost, particularly the ancient balistics, &c; and even if all the knowledge and discoveries of the ancients were continued down to us, some will still question whether the capacities of men in later times are equal to those of former. As to the point of capacity, the Author answers, to avoid dispute, that a cripple in the right way may beat a racer in the wrong; and, as to the knowledge of the ancients, he allows it to have been great, and that only some of their superficial and popular philosophies have descended to us. See above, Aph. 71. So that we can only judge of what we have, though the utmost diligence should, doubtless, be used to recover all the arts, inventions, and philosophies, that flourished among the ancients.

† So far as we know of them.

‡ Observe how the Author endeavours to break the charm, mentioned in the Preface under Aph. 7.

|| Viz. the observations upon which they were formed.

only to the patience of men, and the subtile or regular motion of the hand or instruments. Thus, for example, it is certainly a very subtile and accurate piece of workmanship to make a clock, that shall seem to imitate the revolution of the heavenly bodies, and the pulsation of the bodies of animals, by a regular and successive motion, and yet this depends upon but one or two axioms of nature.*

And if any one shall consider that subtlety shewn in the liberal arts, or the preparation of natural bodies by the mechanic arts, and the like; such, for example, as the discovery of the celestial motions, the notes in music, the letters of the alphabet (which to this day are not used among the Chinese); or, again, in the mechanic arts, the productions of Bacchus and Ceres, that is, the preparation of wine, malt liquors, bread, pastry, the furniture of the table, distillations, &c.; and if, at the same time, he reflect through what a number of years all these (except distillation, which alone is not ancient) are arrived to that degree of perfection wherein we now enjoy them, and yet how little of observation or of the axioms of nature they have in them, (as we instanced before in clocks,) and how readily, or, as it were, by obvious occasions and necessary considerations, they might be discovered; will easily cease his wonder, and rather pity the condition of mankind, that for so many ages there should have been so great a want and barrenness of inventions, yet all the discoveries now mentioned† are more ancient than philosophy and the intellectual arts, so that, to say the truth, when the rational and dogmatical arts came upon the stage, the invention of useful works went off.‡

If a man turns his eyes from the shops to libraries, he may, perhaps, be surprized at the immense variety of books he finds; but, upon examining and diligently weighing their matters and contents, he will be struck with amazement on the other side; and, after finding no end of repetitions, but that men continually treat and speak the same things over and over again, fall from his admiration of the variety into a wonder at the want and scantiness of those things, which have hitherto detained and possessed the minds of men.‖

And again, if any one should condescend to regard such things as are accounted rather curious than useful, and take a thorough view of the works of the alchemists, or the followers of natural magic, he might, perhaps, be at a difficulty which he should withhold, his tears or his laughter; for, the alchemist goes on with an eternal hope, and, where his matter succeed not, lays the blame upon his own errors, and accuses himself as not having sufficiently understood either the terms of his art or his author, whence he either hearkens out for traditions and auricular whispers, or else fancies he made some mistake as to the

* Viz. the law of pendulums, suppose, and elasticity.

† Except distillation, which was excepted before.

‡ If this, upon a fair and full inquiry, shall appear to be the case, it might afford a strong argument against admitting the rational and dogmatical arts, or any philosophy but the practical or experimental kind.

‖ Hence the Author, in another place, observes, that there is a great agreement betwixt the shops of artificers and the libraries of the learned, as both make a great shew of variety, yet contain nothing but infinite repetitions of a few things, or numerous applications of a few principles differently dressed and modelled, according to particular humours, fashions, and exigencies.

exact quantity of the ingredients or nicety of the experiment, and thus repeats the operation without end; and if, in the mean time, among all the chances of experiments, he throws any which appear either new or useful, he feeds his mind with these, as so many earnests, boasts and extols them above measure, and conceives great hopes of what is behind. It must, indeed, be allowed, that the alchemists have made many discoveries, and obliged mankind with useful inventions, but they are well represented in that fable of the old man who left an estate to his children, (buried somewhere or other, he told them, in his vineyard,) which they, therefore, fell to dig for with great diligence, whereby, though they found no gold in substance, yet they received a better vintage for their labour.

But such as apply to natural magic, and explain every thing by sympathies and antipathies, have, by supine and indolent conjectures, placed strange virtues and operations in things, and if, at any time, they have produced works, they are rather suited to admiration and strangeness, than to fruit and advantage.

86. And for superstitious magic, if we were disposed to speak thereof, it would come first to be observed, that there is only one certain and determinate kind of subject, in which the curious and superstitious arts, through all nations, ages, and religions, could take place, and have any effect or impose.* But of this we say no more. In the mean time, it is no wonder if an imagination of great plenty has proved a cause of want.

The admiration of mankind, as to doctrine and arts, which is a simple and almost childish thing in itself, has been increased by the craft and artifice of such as treat and deliver the sciences, who propose them with that state and affectation, or so finely fashioned, and bring them so dressed upon the stage, as if they were perfect in every part, and so many finished things; for, to look upon the methods and divisions of these teachers, they might seem to contain and include every thing that can fall within the subject; and, though the parts are filled up, and in reality little more than empty carcasses, yet they pass currently among the vulgar, as having the form and fulness of complete sciences.†

But the primitive inquirers after truth, with greater fidelity and a happier conduct, used to throw all the knowledge they determined to collect and treasure up for use into aphorisms or short and loose senti-

* The Author appears to mean that the weak and credulous are this subject. He expresses himself, in another place, thus: — The magician, when, according to his own understanding, he sees some things effected that are beyond the power of nature, and thus supposing her to be once forced and subdued, he adds wings to his imagination, and scarcely believes the effect to differ according to the degree of more and less; and, therefore, promises himself that he may obtain the greatest things of all, without considering that they are subjects of one peculiar kind, wherein magic and superstition have had any power and influence, through all nations and ages.—See the Sylva Sylvarum, under the article Imagination and Sympathy.

† This inconvenience is very apt to attend the writing of systems and bodies of sciences, where the writer, having the matter before him, seldom considers of any thing more than how to give it the best form, and render it most agreeable to the Reader. This, though it may usually be esteemed a laudable thing, has yet a pernicious effect, and, doubtless, retards the advancement of the sciences, whence it should be avoided by philosophers and severe inquirers into truth, as a kind of imposture. — See *Tschirnhaus. Medicina Mentis* in init.

ments, not ranged into method, without professing or pretending to set down the whole of an art.*—But, as the case now stands, it is no wonder if men make no farther progress in those things, which are delivered as if already perfected.

87. Things of antiquity have also received an additional reputation and credit, from the vanity and levity of such as offered new ones, especially in the effective and operative part of natural philosophy; for certain boasting and fantastical persons, partly through credulity and partly through imposture, have amused mankind with great prolongation of life, the retardation of old age, the mitigation of pain, the repair of natural defects, cures for the deceptions of the senses, the way of bending and exciting affections, the illumination and exaltation of the intellectual faculties, the transmutation of substances, the strengthening and multiplying of motions at pleasure, the impressions and alterations of the air, the bringing down and procuring of celestial influences, the devination of future events, the representation of things remote, the revelation of secrets, &c. The truth is, there seems to be the same doctrines of philosophy between these vanities and the real arts as there is between the historical narrations of the exploits of Julius Cæsar or Alexander the Great, and the achievements of Amadis de Gaul or Arthur of Britain; for, those celebrated Emperors are found, in fact, to have accomplished greater things than the other shadowy heroes are even feigned to have done, and yet this, by such means as no way fabulous or monstrous;—nor should it detract from the credibility of real history, that it has sometimes been injured and abused with fables. In the mean time, it is not strange that a great prejudice should be raised against new proposals, especially those relating to works, upon account of these impostors, who have attempted the like, whence the excess and disdain of vanity† have, even at present, left no spirit for such great designs.‡

88. But the sciences have been much more hurt by pusillanimity and the slenderness of the tasks which men proposed themselves; and yet, to enhance the mischief, this pusillanimity is not without its pride and disdain.

For, first, it is a common excuse with every artist, to lay the imperfection of his art, as a reproach, at the door of nature, and what his art does not perform, to pronounce, from that art, impossible in the

* The Author thus enforces the present consideration in another place:—the first and most ancient inquirers after truth, with more sincerity and better success, threw the knowledge they gathered from the contemplation of things, and proposed to lay up for service, into aphorisms or short and independent expressions, which, shewing inventions naked as they were, and at the same time indicating the spaces that remained to be filled with discoveries, they were hence the less deceived, and men's thoughts and minds the more excited to judge and discover. On the contrary, the present method is, to place the sciences in such a light as may procure them the most credit, not excite the judgement, and, by a severe authority, to stop inventions in the bud, so that the sciences now descend, as in the persons of master and scholar, instead of inventor and improver, whence no wonder if they are not advanced.

† Viz. excess on one side and disdain on the other, or on the side both of projectors and anti-projectors.

‡ And under this disadvantage the Author lay in his great designs for enriching the kingdom by mineral works, erecting his Solomon's College, his inquiries for prolonging life, commanding the winds and the weather, his new logic, &c.

nature of things, and certainly the art will not be condemned, whilst itself is the judge;—nay, the present philosophy contains and patronizes some opinions, which, if diligently examined, wholly tend to persuade mankind that nothing great or very commanding over nature can be expected from art, or the human powers, (as we instanced above, in the difference betwixt solar and culinary fire, composition, mixture, &c.*) which, in the result, is no other than maliciously to limit men's faculties, and to invent and introduce an artificial despair, that shall not only disturb and unsettle our hopes and expectations, but take away the motives to industry, cut its sinews, and disappoint or prevent all the chances of experience, whilst the artist is only solicitous about this, that his art should be esteemed perfect; thus endeavouring at an exceeding vain and destructive glory, in having it believed that every thing not yet discovered and understood is absolutely impossible to be found out or known;† and, if any one applies himself to nature, and endeavours to strike out something new, yet he will generally propose and fix upon some one invention, without farther search,—for example, the nature of the loadstone, the tides, the theory of the heavens, and the like, which seem to conceal some secret, and have been hitherto unsuccessfully explained; whereas it is in the highest degree unskilful to examine the nature of any thing in that thing itself; for, the same nature, which in some things lies hid and concealed, appears open and obvious in others, so as to excite observation in the one, and to pass unobserved in the other; thus the nature of consistence is not taken notice of in wood or stone, but slighted under the term of solidity without farther inquiry into its avoidance of separation or solution of continuity; whilst the same thing appears subtile and of deeper inquiry, in bubbles of water, which throw themselves into thin skins of a curious hemispherical figure, in order, for the instant, to avoid a solution of continuity.

And again, those very things which are accounted secrets have, in other cases, a common and manifest nature, which can never be discovered whilst the experiments and thoughts of men run wholly upon them;‡ and generally those things are esteemed new inventions in mechanical works that are no more than better ways of finishing, adorning, joining, compounding, rendering more commodious, enlarging, or contracting, the bulk of the old ones, and the like.‖

* See Aph. 75.

† Some will confine this to the more illiterate mechanics and artisans, and others extend it to the liberal sciences, medicine, philosophy, &c.

‡ This transmutation, though expressly endeavoured after to little purpose in some cases, yet in others seems to occur almost spontaneously.—See Sylva Sylvarum, under the articles Alterations and Transmutations.

‖ In another place the Author observes, that, if a mechanic happens to add some ornament and a greater lustre to any former invention, or combines two or three things that before were separate, or fits them more commodiously for practice, or exhibits the thing either in a greater or a less bulk, he presently writes himself in the list of inventors; whence men, 1, disdain the invention of new arts and works as an idle, fruitless, and suspected endeavour; or, 2, believe that there are noble inventions discovered, but that they lie concealed, with the utmost silence and caution, in a few hands; or, 3, take these smaller additions and alterations of invention for new discoveries. All which tends to turn men's minds aside from the true and laborious method of inquiry, and prevents such tasks and discoveries as are worthy of mankind.

So that it is no wonder if noble and worthy inventions, suitable to the dignity of mankind, are not brought to light, whilst men content and please themselves with such slender and childish performances, and at the same time imagine that they perform great matters by them.

89. We must not omit that natural philosophy has, through all ages, had a troublesome and difficult adversary to contend with, viz. superstition, and the blind furious zeal of religion; for, we find among the Greeks, that they who first assigned the natural causes of thunder and storms, whilst the ears of men remained unaccustomed to such explanations, were condemned for impiety against the gods.* Nor did those meet with much better fate from some eminent fathers of the Christian church, who, upon infallible demonstration, which no man in his senses would now oppose, asserted the spherical figure of the earth, and, consequently, the existence of antipodes.

And, as matters now stand, it is still more difficult and dangerous to discourse upon nature, by reason of the summaries and methods of the scholastic divines, who, having imperiously reduced theology to order, and fashioned it into an art, have, at the same time, blended too much of the thorny and contentious philosophy of Aristotle into the body of religion.

And to this head belongs, though in a different respect, the labours of such as have ventured to deduce and confirm the truth of the Christian religion, from the principles and authorities of philosophers; thus, with great pomp and solemnity celebrating the inter-marriage of faith and sense, as a lawful conjunction, and soothing the minds of men with a pleasing variety of matter, though at the same time rashly and unequally intermixing things divine and human; but, in such medleys of divinity and philosophy, only the things at present received in philosophy are comprehended, whilst new ones, though better, are almost rejected and excluded.

Lastly, we find, through the unskilfulness of certain divines, that the passage to any philosophy, though ever so just, is in a manner blocked up; for some weakly suspect, that deep inquiries into nature will transgress the bounds of sobriety; and, injudiciously wresting what is said in Scripture of those who pry into the divine mysteries, apply it to the secrets of nature, from which we are no where forbid. Others, with greater cunning, conceive, that, if the means remain unknown,† all things may be the easier managed by the dexterity of the hand, and the divining rod, which they imagine highly serviceable to religion; but this is no other than offering to God the unclean sacrifice of a lie.‡ Others dread the example, lest the disturbances and changes in philosophy should extend to and terminate in religion. And others, again, seem afraid, lest something should be found in the inquiry of nature to subvert, or at least undermine, religion, especially among the ignorant. These two latter fears appear to us to be deeply tinged with low grovelling wisdom; as if men, in their secret thoughts, cherished some doubt and distrust about the strength of religion, and the power

* See the Clouds of Aristophanes.

† *Viz.* if men are kept in ignorance.

‡ For, knowledge can never make men irreligious, or independent upon God.

of faith over the senses, and therefore apprehend danger to it from the search of truth in natural things; but, whoever rightly considers it, will find that natural philosophy is, next after the word of God, the most certain cure of superstition, and the best support of faith. Philosophy, therefore, is deservedly appointed as the true handmaid to religion; the one manifesting the will, and the other the power, of God; for it was no error in him who said, "Ye err, not knowing the Scriptures and the power of God;" thus inseparably mixing and joining together the information of his will and the knowledge of his power. It is, therefore, the less wonder that natural philosophy has been so little improved, when religion, whose power over men's minds is exceeding great, has, through the ignorance and unwarrantable zeal of some, been made to oppose it.

90. Again, in the customs and institutions of schools, universities, colleges, and the like conventions, destined for the seats of learned men, and the promotion of knowledge, all things are found opposite to the advancement of the sciences; for, the readings and exercises are here so managed, that it cannot easily come into any one's mind to think of things out of the common road; or, if here and there one should venture to use a liberty of judging, he can only impose the task upon himself, without obtaining assistance from his fellows; and, if he could dispense with this, he will still find his industry and resolution a great hindrance to the raising of his fortune; for, the studies of men in such places are confined and pinned down to the writings of certain authors, from which, if any one happens to differ, he is presently reprehended as a disturber and an innovator. But there is surely a great difference between arts and civil affairs, for the danger is not the same from new light as from new commotions. In civil affairs, it is true, a change even for the better is suspected, through fear of disturbance, because these affairs depend upon authority, consent, reputation, and opinion, and not upon demonstration; — but arts and sciences should be like mines, resounding on all sides with new works and farther progress:—and thus it ought to be, according to right reason; but the case, in fact, is quite otherwise. For the above-mentioned administration and policy of schools and universities generally oppose and greatly prevent the improvement of the sciences.

91. And though this contrariety should cease, yet it is sufficient to check the progress of the sciences that such endeavours and such industry are not rewarded;* for, those who cultivate the sciences have not the power of rewarding. The improvement of the sciences proceeds from great capacities, but the salaries and rewards for them lie in the hands of the vulgar, or such rulers of state as are rarely men of considerable learning. And what is more, such kind of advancement not only fails of reward and encouragement, but is destitute even of popular praise, as being above the reach of the crowd, and easily beat down and extinguished by the winds of vulgar opinion. Whence, again, it is no wonder that this business has proceeded no better, whilst, instead of encouragement, it has met with disesteem.

92. But the greatest obstacle of all to the progress of the sciences and the undertaking of new tasks and provinces in them, lies in the despair of mankind and the supposition of impossibility. For, prudent

* See above, Aph. 90.

and exact men generally distrust such kind of attempts, upon considering within themselves the obscurity of nature, the shortness of life, the fallacy of the senses, the weakness of the judgement, the difficulties of experimenting, &c.; whence they conceive that there are certain ebbings and flowings of the sciences, through all the revolutions of times and ages, so as one while to increase and flourish, and another to decline and lie neglected; and, when arrived at one certain state and degree, to become incapable of rising higher. Therefore, if any man should hope or undertake for the contrary, they think it the sign of a weak and unripened judgement, and that such attempts begin with pleasure, proceed with difficulty, and end in confusion.

And as these are thoughts which readily occur to grave and judicious men, we must indeed beware, lest, being ourselves caught with the love of a thing that has an excellent and beautiful appearance, we should slacken the reins of judgement. We shall, therefore, next proceed with care to examine what degree of hope there is of future success, and from what quarter it arises, (with the purpose of rejecting the lighter gales thereof,) and diligently discuss and weigh those grounds that appear the strongest; and here civil prudence also is to be consulted, which distrusts by prescription, and suspects the worst of human affairs.* And, whilst we thus inquire into the grounds of hope, we ourselves make no promises, offer no violence to the mind, and lay no snares for the judgements of men, but only lead them by the hand.

SECTION VI.

OF THE GROUNDS OF HOPE FOR THE FARTHER ADVANCEMENT OF PHILOSOPHY AND THE SCIENCES.

93. Though the most powerful motive of hope will hereafter be delivered, (when we shall lead mankind to particulars, especially as we propose to digest and range them in our tables of invention, which principally belong to the fourth part of our general design,) where things themselves rather than hopes will be offered; yet, that all may be done in the smoothest manner, we shall here proceed in our purpose of preparing the minds of men. And in giving them a view of the hope there is for improving the sciences consists no small part of this preparation; as, without it, all the rest has a greater tendency to deject mankind than to raise them to a cheerful and industrious prosecution of experiments, and only give them a meaner opinion of the things they at present enjoy, and a deeper sense of their own misfortune. We shall, therefore, here open and propose our conjectures for rendering the more favourable expectations of the sciences probable, in imitation of Columbus, who, before he undertook his surprising expedition

* See above, Aph. 75.

through the Atlantic ocean, produced his reasons why he expected to find new lands and continents besides those that were then discovered; which reasons, though at first rejected, yet, being afterwards confirmed by experience, were the cause and origin of very great things.

We begin with God, the Author of all Good, and the Father of Lights, from whom the goodness of this design manifestly shews it to proceed. We see in the divine works, that the smallest beginnings are certainly succeeded by the effects. And what is said of spiritual things, that the Kingdom of God comes not with observation, is also found true in every great work of Divine Providence, where all things go quietly on, without noise or bustle, so that the whole is accomplished before men imagined or took notice that it was in hand; and we should here remember the prophecy of Daniel concerning the latter ages of the world:—"many shall go to and fro upon the earth, and knowledge shall be increased," thereby plainly intimating it to be the design of Providence, that, when the world was laid open to a general intercourse, as by our numerous long voyages it begins to be, at the same time also the sciences should receive increase.*

94. A capital reason of our hope may be also derived from the errors of past times, and the ways that still remain untried. The following reprehension of a civil state, that had shewn little conduct in its affairs, is excellent:†—"What, with regard to past times, is the worst, should, for the time to come, be esteeemed the best; for, if you had performed your duty to the full, and yet your affairs had gone backwards, there would have been no hopes of their amendment; but, as the bad posture of your affairs proceeds, not from necessity, but from your own errors, there is room to hope, that, when those errors are forsaken or corrected, a great change for the better may ensue."—In like manner, if mankind had, for so many ages, held on in the true course of discovering and improving the sciences, and yet could have advanced them no higher, it would indeed be bold and presumptuous to believe them capable of farther improvement; but, if the way itself has been mistaken,‡ and the labour of mankind been bestowed where it ought not, it follows that the difficulty does not arise hence, that things lie out of their reach, but from the understanding itself, its manner of use and application, which may still be remedied.‖ It were, therefore, advisable to enumerate these very errors, for, so many impediments as past errors have proved, so many arguments there are of future hope; and, though we have already touched upon them above,§ yet we think proper here again to represent them in a concise, naked, and simple manner.

95. Those who have treated the sciences were either empirics or rationalists. The empirics, like ants, only lay up stores, and use them;

* We may now be enabled, in some measure, to judge how far these grounds of hope were solid and well laid. Certainly a great revolution in philosophy has gradually ensued upon the endeavours of the Author; and philosophers have been insensibly drawn off from speculation and theory to practice and experience, whence many useful inventions and works have proceeded, and more may, perhaps, proceed.

† The reprehension of Demosthenes to the Athenians.

‡ See above, Aph. 81, 82, 83, &c.

‖ See hereafter, Aph. 105, 106, and Part II. throughout.

§ Sect. V. Aph. 78—92.

the rationalists, like spiders, spin webs out of themselves; but the bee takes a middle course, gathering her matter from the flowers of the field and garden, and digesting and preparing it by her native powers. In like manner, that is the true office and work of philosophy, which, not trusting too much to the faculties of the mind, does not lay up the matter afforded by natural history and mechanical experience entire and unfashioned in the memory, but treasures it, after being first elaborated and digested, in the understanding; and, therefore, we have a good ground of hope, from the close and strict union of the experimental and rational faculties, which have not hitherto been united.*

96. Natural philosophy is not hitherto found pure, but infected and corrupted; in the school of Aristotle, by logic; in that of Plato, by theology; in the second school of Plato, Proclus, and others, by mathematics, which ought only to terminate natural philosophy, and not to generate or create it;† and, therefore, we have another ground of hope, from a natural philosophy, pure and unmixed.

97. No man has yet appeared of so great constancy and firmness of mind as to impose upon himself the total extirpation of theories and common notions, and offer the understanding quite plain and smooth, to receive particulars anew; and, therefore, that knowledge we have is nothing more than an undigested heap and collection of much faith and accident, mixed with abundance of childish notions, imbibed in our youth.‡

Whence, if any one of riper years, sound in his senses, and of a clear unbiassed mind, were to apply himself afresh to experience any particulars, better things might be expected from him. And in this respect we promise ourselves the fate of Alexander the Great. But let us not presently be accused of vanity, before the end of the story be heard, which regards the laying aside of all vanity.

For, Æschines, speaking of Alexander and his exploits, has these words:—"surely we lead no mortal life, but are born to this end alone, that posterity should relate strange things of us." — As if he esteemed the achievements of Alexander miraculous. But Livy coming, long afterwards, to consider and look better into the thing, said of it, that "Alexander did no more than dare to despise vanities." And such a judgement we expect posterity will pass upon us, viz. that we have

* The Author, however, cautiously observes, in another place, that there have been some empirical philosophers, who would not be esteemed merely empirical; and again, some rationalists, who desired to appear industrious and versed in experience; but that this was only the artifice of certain men, in endeavouring to raise themselves a character and reputation for excelling in their different sects, whilst in reality the two faculties were ever separated, and almost opposed to each other.

† Here seems to be a direction of great moment for the advancement of genuine philosophy, which certain men conceive cannot be so effectually promoted as when mathematics preside therein and direct. But this should be farther considered, and without partialities to mathematics; for, the logician would have his art preside in philosophy, the chemist his, and the metaphysician is apt to reduce all to abstraction and ideas.— Certainly philosophy should refuse none of these helps; but, to make choice of any one of them, so as to exclude the rest, must needs occasion a partial philosophy; and hence the chemical philosophies, the logical philosophies, the mataphysical philosophies, and even the mathematical philosophies, cannot, perhaps, be safely depended upon.

‡ See above, Aph. 19, 27, 28, 29.

done no great matter, but only esteemed those as little things which were accounted great ones.—In the mean time, there is no hope, as we before observed, but in the regeneration of the sciences, or the raising and building them up anew, in a certain order, from experience, which no one, perhaps, has hitherto attempted or thought of.*

98. And for the foundations of experience, which is the next thing we must proceed to, they either have not hitherto been laid, or very weakly. Nor has a collection of materials, competent either in number, kind, or certainty, for informing the understanding, or any way sufficient and worthy of the end proposed, been hitherto made; but, on the contrary, learned men, after an easy indolent manner, have received certain rumours of experience, and the popular reports and tales thereof, both for building and strengthening their philosophy, and given them the weight of strong testimonials; which is just as if a kingdom should govern itself, not according to the advices and intelligences of its ambassadors and trusty servants in foreign courts, but by the idle rumours and common-talk of its people;—for, as to matter of experience, there is nothing hitherto well discovered, verified, weighed, or measured, in natural history, but whatever is undefined and vague in observation must needs be fallacious and deceitful in the information; and, if this shall seem surprizing, or the complaint appear unjust to any one, whilst so great a philosopher as Aristotle, assisted with the purse of so great a prince as Alexander, has compiled such an exact history of animals, and, whilst some others, with greater diligence, though with less bustle, have contributed many things thereto, and whilst others again have written copious histories and accounts of plants, metals, and fossils,—he does not seem sufficiently to understand our meaning. A natural history, compiled for its own sake, is one thing, and a natural history, collected for informing the understanding, in order to the building up of natural philosophy, is another. And these two histories, as they differ in other respects, so principally in this, that the former contains various descriptions of natural bodies, but not experiments of mechanic arts. For, as in civil life, the temper of a man and the secret dispositions of his mind and affections, are better understood when he is ruffled than otherwise, so the secrets of nature are better got out by the torturing of arts than when suffered to take their own course; and, therefore, we may then have good hopes of natural philosophy, when natural history, which is the basis thereof, shall be better supplied, and not before.

99. Again, in the very stock of mechanical experiments, there is a great want of such as principally conduce to the information of the understanding; for, the mechanic, being no way concerned about the discovery of truth, applies his mind and stretches out his hand to nothing more than is subservient to his work; but we may then rationally expect to see the sciences farther advanced, when numerous experiments shall be received and adopted into natural history, which of themselves are useless, and tend only to the discovery of causes and axioms: these being, what we call, experiments of light,

* Let antiquity be farther searched upon this head, as also the Chinese history, and the histories of other ancient nations consulted, to see if nothing of this kind was ever proposed before. What the Author means will fully appear hereafter, under Sect. VII. but more particularly in the Second Part of this Work. See also above, Aph. 21.

to distinguish them from experiments of profit; and they have this wonderful property, that they never deceive or frustrate the expectation; for, being used not in order to effect any work, but for disclosing of natural causes, in certain particulars, let them fall which way they will, they equally answer the intention and solve the question.

100. And not only a larger stock of experiment is to be sought and procured, of a different kind from what has hitherto appeared, but also a quite different method, order, and procedure, is to be introduced, for continuing and advancing experience itself; for, vague experience, that pursues nothing but itself, is, as was before observed, a mere groping about in the dark,* and rather amazes mankind than informs them; but, when experience shall be conducted by certain laws, orderly and consequentially, we may have better hopes of the sciences.

101. And when a proper quantity of suitable materials for such a natural and experimental philosophy, as is required for the work of the understanding, or the business of philosophy, shall be provided and got ready, yet the understanding is no way qualified to act upon these materials spontaneously and by memory, no more than a man should expect to make the calculations for an almanack by the bare strength of his memory. Yet contemplation has hitherto been more employed in invention than writing, nor is experience yet made learned;—but no invention should be allowed, or trusted, except in writing; and, when this comes into use, so that experience may be made a matter of learning and science, we may then have better hopes.†

102. Again; the number, or, as it were, the army of particulars, being so large, scattered, and confused, as to distract and confound the mind, little good can be expected from the skirmishes and sallies of the understanding, unless it be fitted and brought close to them, by means of proper, well-disposed, and actuating, tables of invention, containing such things as belong to the subject of every inquiry, and unless the mind be applied to receive the prepared and digested assistance they afford.‡

103. And even when a stock of particulars is exactly and orderly placed before us, we must not immediately pass on to the inquiry and discovery of new particulars or works; at least if this be done, we must not dwell upon it. We deny not, that after all the experiments of every art shall be collected, digested, and brought to the knowledge and judgement of a single person, many new discoveries may be made, for the use and advantage of life, through the translation of one art into another, by means of what we call learned experience; yet less hope is to be conceived hereof, and a much greater of a new light of axioms, drawn regularly, and in a certain manner, from those particulars, so that such axioms may again point out and lead to new

* See above, Aph. 82.

† The caution here laid down is extremely necessary; for, the natural powers of the mind are so infirm and weak as by no means to be trusted in the business of invention, observation, or experiment. We see it is common for men, after some time, to forget their own observations and experiments. Nor is the memory sufficiently ready and apt to present things as they may be wanted, nor the judgement always clear, strong, and in right order. So that even natural things, whilst they dwell only in the memory or imagination, seem little better than phantoms, and require to be distinctly written down for the service of philosophy.—See hereafter, Part II. passim.

‡ See hereafter, Part II. Sect. I.

particulars; for, the way lies not through mountains and valleys, first ascending to axioms, and then descending to works.*

104. But the understanding must not be allowed to leap or fly from particulars to remote or the most general kind of axioms at once, (such as are called the principles of arts and things,†) and so prove and draw out middle axioms, according to the established truth of the former, as has hitherto been done by a natural sally of the understanding, which is naturally inclined this way, and has been long trained and accustomed to it by the use of those demonstrations which proceed upon syllogism.‡ But we may conceive good hopes of the sciences, when, by continued steps, like real stairs, uninterrupted or broken, men shall ascend from particulars to less axioms, and so on to middle ones, from these again to higher, and, lastly, to the most general of all; for, the lowest axioms differ not much from bare experience,‖ and the highest and most general ones, as they are now esteemed, prove only notional, theoretical, and of no solidity; whilst the middle axioms are the real, the solid, and animated kind, wherein the affairs and fortunes of men are placed;§ and above these, come such as are truly the most general, yet not metaphysical, but justly limitted by these intermediate ones.**

And, therefore, the understanding does not want sail so much as ballast, to keep it from skipping and bounding; but, as this is hitherto a desideratum, when it shall be supplied we may have better hopes of the sciences.

105. Again; a different form of induction from what has hitherto been used must be invented for the raising of axioms, and that not only for the discovering and proving of principles, as they are called, but likewise for ascertaining the smaller, middle, and, in short, all kinds of axioms. For, that induction which proceeds by simple enumeration, is a childish thing, concludes with uncertainty, stands exposed to danger from contradictory instances, and generally pronounces upon scanty data, and such only as are ready at hand;†† but the induction useful in the discovery and demonstration of arts and sciences ought to sift nature by proper rejections and exclusions, and then conclude upon affirmatives, after the due number of negatives are thrown

* This will be more fully explained in the Second Part. The Author intended to treat of the ascending and descending Scale of Axioms, as a part of the present work, but it was never published, And, as this method has not, that we know of, been hitherto tried, it affords an argument of hope, that philosophy and the sciences may be improved by its means.

† Suppose the fiction of the four Peripatetic Elements, which have been made the basis of natural philosophy; the salt, sulphur, and mercury, of the chemists; the Fuga Vacui, &c.

‡ See above, Aph. 13, 14, 19, 20, 25, &c.

‖ Such as in chemistry, that animal substances yield no fixed salt, by calcination; in music, that concords, intermixed with discords, make harmony, &c.

§ Such as in optics, that the angle of incidence is equal to the angle of reflexion in all sorts of surfaces; in physics, Sir Isaac Newton's three laws of motion, &c.

** The highest sort may be called Axioms of Axioms, and were intended to have been treated at large by the Author; but it should seem that philosophy in the general, or the Author's method in particular, has not been so far prosecuted as to afford them.

†† See above, Aph. 13, 17, 19, 20, 24, 25, &c.

out, a thing never yet done, nor attempted, unless by Plato, who made some little use of this form of induction in the sifting of definitions and ideas;* but, for the just and regular forming of this induction or demonstration, numerous particulars are required which have been hitherto thought of by no mortal, so that greater pains must be bestowed upon it than has hitherto been upon syllogisms; and the assistance of this induction must be used, not only for the discovering of axioms, but also for the defining of notions.† — And in this business of induction is lodged the greatest hope of improving the sciences.

105. But in forming these axioms by this induction, it must be well examined and tried whether the axiom intended be only adapted and made according to the measure of those particulars from which it is extracted, or whether it be larger and extend beyond them.‡ If it be more extensive, regard must be had whether it confirms its own extensiveness, by promising well, that is, by designing or pointing out new particulars, lest, otherwise, we should either stick in things already known, or else, with a weak endeavour, catch at shadows and abstract forms, and not grasp such things as are solid and fixed in matter;‖— and, when this practice shall take place, a solid hope will justly attend it.

107. And here should be repeated what we said above concerning the extending of natural philosophy, and the bringing particular sciences back again thereto,§ so as to prevent all rending and dismembering of the sciences; for, unless this be done, there is less hope of their farther advancement; — and so much for preventing despair, and exciting hope, by way of forsaking or rectifying the errors of times past. We proceed next to consider what other motives of hope are still behind:

108. And, first, since many useful things have been discovered, as it were, by accident or necessity, without any inquiry or particular regard on the side of men, there can be no doubt but, if men were to look out and bend their minds to it in a certain method and order, and not by fits and starts, that many more discoveries would be made. For, although it may now and then happen that a man shall accidentally hit upon a thing which had before escaped a great and diligent search, yet, questionless, the contrary is found in the whole of things; and, therefore, many more and much better discoveries are to be expected from the reason and industry, the direction and intention, of mankind, and that in less time than from chance, the instinct of brutes, &c. which have hitherto given the first hints of discoveries.**

* See Aph. 71.—This business of induction is farther explained in another place, thus,—such a form of induction may be introduced, as to draw some general conclusion from certain particulars, so as at the same time to demonstrate, that no contradictory instances can be found; for, otherwise, we might easily pronounce upon too few particulars, and these also of the obvious kind.

† See Aph. 19.—See also Part II. Sect. I. passim.

‡ These are the axioms which the Author principally intends, viz. not such as shall be made to fit a few particular instances, which are no more than naked expressions of the result of certain facts, but such as shall far exceed the particulars whence they were drawn, mark out new particulars, and lead to greater discoveries.

‖ The meaning of this is largely explained in another part of this Work.

§ See Aph. 80. ** See Aph. 74—85

109. It may likewise be an argument of farther hope, that some of the things already discovered are such as, before their discovery, did not enter into men's minds even to suspect, so that any one would have despised them as impossibilities; for, it is a usual way with mankind to form conjectures of new things, according to the examples of old ones, and according to the opinion thence pre-conceived and entertained, which is a fallacious manner of judging, for, many particulars derived from the fountains or origins of things do not flow in the common channels.*—So, if a man, before the discovery of ordnance, should have thus described the thing by its effects, that there was a certain way of battering down walls and the strongest fortifications at a great distance, men's thoughts would have run upon multiplying the force of their common engines of war, the known battering-rams and machines, by the means of weights, wheels, and the other mechanical powers; but scarcely any one would have suddenly fallen upon the invention of raising a fiery wind that should blow out of a tube with such a prodigious expansive violence as to produce the above-mentioned effect; an obvious example thereof having never been seen, unless, perhaps, in earthquakes or thunder-storms, which, as being grand works in nature, men would presently have rejected as inimitable by art.†

So, likewise, before the invention of silk, if any one should have said there was a certain way of making a certain cloth and household furniture far exceeding that of linen or of woollen in fineness, strength, gloss, and softness, men would have fallen to conjecturing about some vegetable silk, the finer furs of animals, or the feathers and down of birds, without ever dreaming it should proceed in such plenty from the spinning of a small worm: and, if any one should have but dropped a word about such a worm, he would certainly have been laughed at, as the projector of a new spider-work.

So, again, if, before the use of the compass, any man had said that a certain instrument was known for exactly discovering the quarters and points of the heavens, men's invention would hence presently have run upon more exact construction of astronomical instruments, and various ways of applying them; but that any thing should be found whose motion had such a correspondence to the heavenly bodies, and yet the thing itself be no celestial, but only a bare terrestrial, stony, or metallic substance, would have seemed absolutely incredible; yet these and the like particulars have been hid from mankind for so many ages, and at last were not discovered by philosophy or the rational arts, but by chance or accident, and are of such a nature as to appear perfectly foreign and remote from the things known before, so that no previous notion could any way lead to them.—Whence there is great room to expect, that there still remain in the bosom of nature many things of excellent use that have no manner of relation or analogy to the things already discovered, but lying perfectly out of the road of the imagination,‡ and which, though hitherto unknown, may, doubtless, through numerous revolutions and successions of ages, be one time or other

* See Aph. 24.

† It cannot be too carefully remembered, that all our knowledge is in proportion to what we have seen, and not to what is contained in nature.

‡ Such as the bark and other specifics in medicine; phosphorus, aqua fortis, and aqua regia, in chemistry; the use of lead and antimony in refining, &c.

discovered, as those above-mentioned have been;—but, by the method we propose, they will more readily and suddenly be represented and anticipated* at once.†

110. There are also other inventions of such a kind as to shew that men may pass by and overlook noble discoveries which lie before their feet; for, though the invention of gunpowder, silk, the compass, sugar, paper, &c. may seem to depend upon certain properties of things and of nature, yet, doubtless, the art of printing contains nothing that is not open and in a manner obvious; but men, not observing, that, though it were harder to range the types of letters than to draw letters by the hand, yet there was this difference, that the types of letters, being once set, would serve for numerous impressions, whilst characters drawn by the hand afforded only a single writing; or, perhaps, not reflecting that ink might be so thickened as to stain without flowing, especially if the face of the letter stood upwards, and the impression was struck downwards; the world has, for so many ages, been without this admirable invention, which so nearly concerns the propagation of knowledge.—And in this course of invention, the mind is frequently so perverse, childish, and contradictory, as first to distrust and presently afterwards to despise itself; for, men first conceive it incredible that any such discovery should be made, but, after it is once made, they

* That is, be discovered, or, at least foreseen in the mind, and the ways of bringing them into use discerned much sooner than by waiting the ordinary or slow-paced course of things, as is shewn in another part.

† The following Aphorism, found detached in another place, may deserve to be added here:—

1. "It may, perhaps, seem incredible to many, that there should still remain undiscovered any considerable number of useful and beneficial works; and again stranger that they should hereafter be discovered of a sudden, and great, to be sure, will be the wonder what these particular works can be. The direct answer is, that, as the ignorance of mankind has led them into despair, so knowledge will lead them out of it into the regions of hope, or rather of certainty; but, whoever duly considers it, will not find it strange, if our method of interpreting nature prevails, that there should, in a small compass of time, many new and useful inventions grow up, for the births of time are slow.—And all the noble inventions at present in use rather proceeded from accident and random trials or conjectures than from any previous light of knowledge; whereas the method of discovering by induction is certain, regular, and direct, without waiting for accidental hits and lucky chances.

2. "And, that there may still remain new discoveries to be made, at least with regard to ourselves, may be fairly argued from hence that we have no certain knowledge of all the inventions known to former ages, the different countries of the world, or to all particular persons. And it is certain, were it not for men, we should never have seen multitudes of those things we at present enjoy, especially those vulgarly called productions of art, such as cloth, coin, &c.—and, to consider it closely, mankind will be found directed by certain motions which they obey in their discoveries.—These motions, indeed, appear subtile and hard to be distinctly comprehended and understood, but are not less certain for that;—and though, in this case, men may be said to obey their own will, that alters not the nature of the thing, for, will in man acts like that called fortune or accident in the world. Such things, therefore, as require the assistance of men to produce, and have hitherto lain quite out of their road, may be reasonably expected from this new method, which was unknown to former ages; for, men sometimes stumble upon things before they are aware of them, and go in quest of others with a certain view, and such means as they know; but the knowledge of the means for discovery has hitherto come by common observations and obvious experiments; whereas our method tends to produce such works as have neither an obvious operation, nor an obvious light, being, indeed, no other than the works of knowledge that are not otherwise producible than by pure science and direct interpretation, neither of them obvious, but removed infinite degrees from such things as are common."

again think it incredible that it was not found out before; and hence we justly deduce another ground of hope, that there may still remain a large treasury of invention, deducible not only from the unknown operations to be hereafter discovered, but also from transferring, compounding, and applying, those already known, by the means of what we call learned experience.

111. As a farther ground of expectation, men may please to consider the infinite expense of genius, time, and treasure, that has been bestowed upon things and studies of very little use and value, whilst, if but a part thereof were employed upon sound and serviceable matters, every difficulty might be conquered. And this we think proper to mention here, because we must confess that such a collection of natural history as we have measured out in our mind, and such as really ought to be procured, is a great and royal work, requiring the purse of a Prince and the assistance of a People.

112. And let no man shrink at the multitude of particulars required, but turn this also to an argument of hope; for the particular phœnomena of arts and nature are all of them like sheaves, in comparison of the inventions of genius, when disjoined and metaphysically separated from the evidence of things. The former road soon ends in an open plain, whilst the other has no issue, but proves an infinite labyrinth, for men have hitherto made little stay in experience, but passed lightly over it; and, on the other hand, spent infinite time in contemplation and the inventions of genius, whereas, if we had any one at our elbow who could give real answers to the questions we should put about nature, the discovery of causes and of all the sciences would be a work but of a few years.*

113. We judge, also, that mankind may conceive some hopes from our example, which we offer, not by way of ostentation, but because it may be useful. If any one, therefore, should despair, let him consider a man as much employed in civil affairs as any other of his age, a man of no great share of health, who must, therefore, have lost much time, and yet, in this undertaking, he is the first that leads the way, unassisted by any mortal, and stedfastly entering the true path that was absolutely untrod before, and, submitting his mind to things, may thus have somewhat advanced the design. — And, after this, let him who desponds consider what may be expected from men of leisure, a conjunction of labours and a succession of times, proceeding upon the notices we have given them, especially as it is in a way not open to certain persons, as the rational way is,† but where the labours of all men, especially in the collecting of experiments, may be well distributed, employed, and afterwards joined together, for then it is that mankind will begin to know their own strength, when not infinite numbers shall perform the same things, but some execute one thing and some another.

114. Lastly, although a much weaker and fainter breeze of hope should breathe from the new continent,‡ yet we must absolutely deter-

* It may here add some weight to find that general scholar, Dan. Geor. Morhof, of opinion, that the Author himself was equal to the interpretation of all nature, if he had not been prevented by civil business.—See Morhof. Polyhist. tom. ii. p. 381.

† See Aph. 95.

‡ The future prospect of improving the sciences.

mine for the business of experimenting, unless we had rather be quite abject and desponding; for it is not equally dangerous trying and not to succeed, because trial has a chance but of a small loss of labour. — To sum up all, it appears to us, both from what has been said, and what remains unsaid, that there is hope sufficient, not only for a man of courage to try, but also for a prudent and sober man to believe.*

115. And thus much by way of removing despair, (which is a principal cause of the slow progress of the sciences,) at the same time finishing what we had to offer concerning the signs and causes of errors, and the prevailing indolence and inactivity of men; for, as to the more subtile causes, which come not under popular judgement or observation, they should be referred to what we have said above concerning the idols of the mind.†

And here likewise must end that part of our work which regards the pulling down of the old structure, and which is effected by three kinds of confutation, viz. 1. the confutation of the natural reason when left to itself; 2. the confutation of the manner of demonstrations; and, 3, the confutation of the received theories or prevailing philosophies and doctrines; and this latter confutation has been such as it might be, viz. derived from signs and the evidence of causes; for, no other confutation could possibly be used by us, who differ from all others in principles and demonstrations.‡ It would, therefore, be time to proceed to our rule and art of interpreting nature, did not something still lie in the way that requires to be removed; for, as we proposed by an introductory set of aphorisms to prepare the mind as well to understand as to receive what is to follow, having now levelled and polished the mirror, it remains that we set it in a right position, or, as it were, with a benevolent aspect to the things we shall farther propose; for, in every new undertaking, not only the being strongly prepossessed with an inveterate opinion, but also a false notion or expectation of what is to follow, proves sufficient to give a prejudice. We must, therefore, next endeavour to establish a just and true opinion of the thing we intend, though this opinion be only temporary, and of use but till the thing itself is well understood.

SECTION VII.

AN IDEA OF THE NEW METHOD OF INTERPRETING NATURE.*

116. We postulate it of mankind, that they would not imagine we have any design to form a sect in philosophy, after the manner

* But the greatest argument with most is good success, which, in this case, has not been wanting, so as to encourage a farther prosecution of this design, upon as just foundations as the merchant traffics.

† See Sect. II.

‡ See Aph. 35.

‖ The idea given in this Section of the Author's method of interpreting nature, is rather a negative than a positive idea, and formed by excluding what it is not, rather

of the ancient Greeks, or some of the moderns. This is far from our view. Nor do we judge it material to the fortunes of mankind, what abstract opinions any one entertains of the nature and principles of things; no doubt but many of these may be borrowed from antiquity, and many new ones be introduced. Thus, for example, a great variety of hypotheses, though different among themselves, may well enough solve the phænomena of the heavenly bodies.* — We are not solicitous about such useless things as depend upon opinion; but, on the contrary, resolve to try whether we can lay any firmer foundations of the human power and greatness, and enlarge the bounds thereof. — And, although we have, as we conceive, discovered certain particulars much more just, true, and advantageous, than those at present in use, yet we lay down no one entire or general theory, for the time is not yet come, nor have we any hopes of living to finish the whole of our work, which is destined to receive a philosophy discovered by the genuine interpretation of nature, but hold it sufficient to carry ourselves soberly and usefully in moderate things; and, in the mean time, to sow the seeds of pure truth for posterity, and not be wanting in our assistance to the first beginning of great things.

117. And, as we are no founders of a sect, so are we no promisers of particular works. But here it may be replied, that we, who so frequently make mention of works, and refer all things to them, should also give some earnests of them; but our design, as we have often said, is not to derive works from works, or experiments from experiments, like empirics; but, like true interpreters of nature, from works and experiments to derive causes and axioms, and from these causes and axioms, new works and experiments; — and, although any one of tolerable diligence and perspicuity may find in our tables of invention, as also from the examples of particulars produced in the second part of the present piece, and again, in our observations upon the history described in the third part, may every where find indications and designs of numerous noble works, yet we ingenuously confess that the natural history we have hitherto been able to procure, either from books or our own inquiry, is not so copious and so well verified as alone to serve for or even administer to a genuine interpretation of nature.† And, therefore, if any one finds himself disposed and fitted for going upon mechanical works, and has a sagacity at discovering them from barely conversing with experiments, we leave him free, and recommend it to his industry to collect many particulars from our history and tables, as it were in passage, and apply them to works, after the manner of interest, for a

than by directly shewing what it is, which will be the business of the Second Part to unfold. But this Section was necessary to give some glimpse of the thing itself, and prepare the mind, by degrees, for the great light to be afterwards set up.

* Observe, that the most elegant and plausible solutions of phænomena may be far removed from truth, and that various contradictory and yet equally probable solutions, may be frequently given of the same appearance. So that, to solve phænomena hypothetically is a weak and childish thing in philosophy, or no better than the sport of fancy and imagination.

† This seems no way spoke out of modesty, but as the real truth, whence the principal thing, in order to a just and full interpretation of nature, is to procure an extensive and faithful history of nature and art.

time, till the principal may be received.* But, as ourselves endeavour after greater things, we here condemn all hasty and unseasonable stops, as being like the stopping of Atalanta, (a comparison we frequently use,) for we do not childishly affect golden fruit, but place the stress of the whole course upon the victory of art over nature, and we are not so eager as to reap moss for corn, or the tender blade for ears, but wait with patience the ripeness of the harvest.†

118. And some, without doubt, upon reading our history and tables of invention, will meet with experiments not well verified, or even absolutely false, and may thence, perhaps, be apt to suspect that our inventions are built upon doubtful principles and erroneous foundations.—But this is nothing, for such slips must necessarily happen in the beginning. — It is but as if here and there a letter should be misplaced or mistaken in a writing or printed book, which does not usually much interrupt the reader, as such errors are easily corrected, from the sense of the place. In the same manner, let men observe, that experiments may be falsely believed, and received in natural history, and yet after be expunged and rejected when causes and axioms are discovered,‡ though, it is true, that, if there should be many and frequent and continued errors in a natural and experimental history, they cannot be corrected by any felicity of art or genius; and, therefore, if in our natural history, which is collected and examined with so much diligence, so rigorous, and, as it were, with so religious a severity, there should sometimes happen any falsity or mistake with regard to particulars, what must be thought of the common natural history, which, in common with us, is so negligent and remiss, or what of the philosophy and the sciences, built upon such quicksands?‖ Let no one, therefore, be concerned, if our history has its errors.

119. There will also occur, in our history and experiments, many things that appear at first sight; (1.) trifling and vulgar; (2.) filthy, sordid, and unpolite: (3.) too subtile and merely speculative, or as if it were useless, which may disgust and alienate the minds of men from considering them.

(1.) But, as for what our history may contain of vulgar, let men reflect, that they hitherto usually do little more than refer and accommodate the causes of such things as are rare to such as are more common,

* It is no difficult matter, from the tables, larger observations, improveable axioms, and variable canons, that occur in the Author's several pieces, to draw out models and patterns of considerable works, or new practical arts of importance; only, as philosophy is hitherto very imperfect, these models will scarcely be perfect in the first essays, but may require many amendments before they will answer.—Whereas, in the Author's manner of proceeding, it would be easy to form a just notion of the thing designed, and then directly put it in practice, without danger of miscarrying. But there are few that seem to apprehend the practicability hereof.

† See the Fable of Atalanta explained, in the Sapientia Veterum.

‡ It must be carefully observed, that even a large number of errors or falsities in a natural history, designed for the foundation of philosophy, would not render it useless for the purpose, unless the number of errors should exceed the number of truths it contained; for, in that case, indeed, the causes here mentioned would be wrongly assigned and the axioms erroneous; — but this cannot happen where more truth than falsity prevails, and a few causes and axioms, discovered and formed though but with tolerable exactness, may discover the depravity or errors of particular facts and experiments.—This will appear plainer in another part of this Work.

‖ The case requires no more than *Argumenta ad hominem.*

without searching for the causes of those that frequently happen, but only receive them as granted and allowed.

Thus they seek not the causes of gravity, of the celestial motions, of heat, cold, light, hardness, softness, rarity, density, fluidity, consistency, animation, inanimation, similarity, dissimilarity, organization, &c. but discourse and judge of things evident, manifest, and received, and thence of others, which occur less frequently and familiarly; but, as we are well apprized that no judgement can be made of uncommon and remarkable things, much less that any new ones should be brought to light, unless the causes, and the causes of the causes, of common things, are justly examined and discovered, we are necessarily obliged to receive the commonest things of all into our history; and, indeed, we find nothing proves more prejudicial to philosophy than that such things as are obvious and often occur should not arrest and detain the consideration of mankind, but are only received transiently, without inquiring into their causes, whence information is not so frequently wanted in things unknown, as attention in such as are known.

120. (2.) But for unpolite or even sordid particulars,* which, as Pliny observes, require an apology for being mentioned, even these ought to be received into natural history, no less than the most rich and delicate; for, natural history is not defiled by them any more than the sun, by shining alike upon the palace and the privy; and we do not endeavour to build a capital, or erect a pyramid, to the glory of mankind, but to found a temple in imitation of the world, and consecrate it to the human understanding, so that we must frame our model accordingly; for, whatever is worthy of existence, is worthy of our knowledge, but ignoble things exist as well as the noble; -nay, as some excrementitious matters, for example, musk, civet, &c. sometimes produce excellent odours, so sordid instances sometimes afford great light and information. But enough of this, as such a delicacy is perfectly childish and effeminate.

121. (3.) It deserves a much closer consideration, that many particulars in our natural history will, to an ordinary capacity, or even to any mind accustomed only to the present philosophy, appear like certain laboured useless subtleties; and, therefore, this objection deserves a primary regard. We have already observed, that at the beginning, and for a time, we seek experiments that may afford light not profit; in imitation of the Creator, who, as we must often repeat, produced nothing but light for the first day's work.

And to pretend that these subtile things are useless, seems like imagining that light has no use because it is not a solid or tangible body; and, in reality, the knowledge of simple natures,† well examined and defined, is like light, and illuminates all the dark recesses of works; and though of no great use in itself, yet potentially includes and draws after it whole troops and armies of works, and fountains of the noblest axioms;—so the letters of the alphabet, separately and of themselves, are insignificant and useless, yet prove like first matter in the formation or composition of all speech and discourse. Even the seeds of

* Such, for example, as observations and experiments upon putrefaction, the excrements of animals, &c.

† Such as heat, cold, gravity, fluidity, &c.

things, though of such great efficacy, are useless, without the proper treatment; and the scattered rays of light itself, unless brought close together, do not impart their virtue. But if any one be offended at speculative subtilties, what would he say to the schoolmen, who have given in to subtilties without end?—And yet these subtilties were about words, or at least vulgar notions, which comes to the same thing, and not about nature; and have proved also as useless in their consequence as in their origin; being not of that kind to be useless for the present, but infinitely useful in future, as those are whereof we now speak.—And mankind may be certain of this, that all subtilty of dispute and reasoning of the mind, if used only after axioms are discovered, comes too late and out of season: and that the true, proper, or at least the principal, time for subtilty, is in contemplating experience, and forming axioms from it,* for that other kind of subtilty catches at nature without ever taking hold of her: and what is usually said of opportunity or fortune, holds perfectly true, if transferred to nature, viz. that she has locks before, but none behind.

Lastly, with relation to this contempt of natural history, on account of its containing things that are vulgar, ignoble, subtile, or useless in their origins, we should here consider as an oracle the saying of the poor woman to the haughty Prince, who rejected her petition as a thing below his dignity to take notice of:—'then cease to reign!' for it is certain, that, whoever will not attend to matters of this kind, as if they were too minute or trifling, shall never obtain command or rule over nature.†

122. It may also seem a strange and shocking thing, that we should at once reject all the sciences and all authors at a stroke, without admitting any one of the ancients to assist or defend us, but trust, as it were, to our own single strength.

We are well aware, that, if we were any way disposed to act insincerely, it would not be difficult for us to attribute what we produce either to the early ages,‡ (when, perhaps, the knowledge of nature flourished more, though with less pomp, than after it came into the flutes and trumpets of the Greeks,) or even, in certain particulars, to some of the Greeks themselves, and thence derive authority and honour to our inventions, after the manner of new-raised persons, who

* This alone is what properly deserves the name of theory in philosophy, that is, the viewing or considering in the mind how things are in nature, and thence forming axioms, or rules of practice, for producing works and effects. For want of attending to this fundamental point, men are apt to imagine that philosophy is a light airy thing, wherein every one may amuse himself, by raising hypotheses and building systems, without the drudgery of consulting nature and experience. But let it be well remembered, that the end of philosophy is practice, or that philosophy is no farther of use than as it may be made operative.

† This whole Aphorism will, if duly considered, appear self-evident.

‡ This might have been an easy artifice for the Author, considering how well versed he was in antiquity, and what a talent he had at explaining the mythology thereof; but this would, indeed, have been an imposition or imposture, since no evident signs of any such inductive method as that he próposes are found in the ancients; but, though the Author does not use this artifice, it is certain he has used a particular art, in procuring credit and reputation to his inventions. But what kind of art this is deserves, perhaps, like the art of government, to be in some measure concealed. Certainly the subtilty of the serpent may be joined with the innocence of the dove. — See hereafter, Aph. 128.

fetch their nobility from some ancient line, by the favour of genealogies and descents. But, relying wholly upon the evidence of things, we reject all stratagem and imposture,* and judge it of no greater moment to the business in hand, whether what shall be now discovered was known to the ancients, and by the vicissitude of things and ages is made to set and rise, than to be solicitous whether America is the island Atlantis mentioned by Plato and known to the ancients, or whether it were first discovered by Columbus; for, the discovery of things is to be derived from the light of nature, and not from the darkness of antiquity.†—But, as to the general censure of striking out all authorities and all the sciences at once, certainly, whoever considers it rightly, will find this procedure more rational and more modest than to have done the thing but in part; for, if errors had not been rooted in men's first notions, some things, justly discovered, might have rectified others; but, as errors have been fundamental, and of such a kind that men have rather neglected and passed things over, than formed a wrong or false judgement about them, it is no wonder if they have not obtained what they never had in view, — not arrived at the end they never proposed, nor performed the course which they never entered;‡—and, as to the point of insolence, it is true, that if one man should, by the steadiness of his hand and the strength of his eye, pretend to draw a more perfect right line or circle than another, there would then be a competition of excellence; but, for a man to assert, that, by the ruler or compass, he can draw a more perfect line or circle than another, by the sole use of his hand and eye, is surely no great matter of ostentation; and this holds good, not only in our present first attempt, but regards those also who shall endeavour to improve it after us; for, our way of discovering the sciences almost levels the capacities of men, and leaves little room for excellence, as it performs all things by sure rules and demonstrations; and therefore these discoveries of our's are, as we have often said, rather owing to felicity than any great talent, and are rather the production of time than of genius; for there is, doubtless, no less of accident in the thoughts than in the works and actions of men.

123. And therefore we may say of ourselves what was formerly said in the way of pleasantry,—that it is impossible those who drink water

* In another place, the Author mentions, that, if he were disposed to deal collusively with mankind, it would be no difficult matter to persuade them that the ancient philosophers, long before the times of the Greeks, had a much deeper knowledge of nature, and thence artificially insinuate, that they prosecuted inquiries in the method himself proposes, whence he imagines he might have gained over to his side all the admirers of antiquity, or those who rest upon authorities, which are a large number, and thus have found the less opposition in his promoting his grand design. But, though himself appears to have conceived highly of the knowledge of the earliest ages of the world, as we find by his piece, *De Sapientia Veterum*, yet he rejects this artifice as dishonest.

† Notwithstanding the high opinion which the Author entertained of antiquity, he tells us in another place, that, after having examined all the sects of philosophy among the Greeks and other nations, he turned his eyes upon early antiquity, which he found as a remote tract, covered with clouds and hid in obscurity.

‡ This sentiment is differently expressed in another place, thus,—"As to the rejection of former doctrines, this must be understood only of opinions, and not as derogating from the genius or labours of the Authors that have gone before us; for, the greater genius any man has, and the more pains he takes, after having left the light and history of nature and the evidence of particulars, into the more dark and intricate dens and dungeons of fictions and idols, he runs and becomes involved."

should have the same sentiments with those that drink wine,* for all mankind, both ancients and moderns, have drunk a crude liquor in the sciences, as a water that either flowed spontaneously from the understanding, or was drawn out of the well by the wheels of logic; whilst we drink a liquor, and offer it to others, prepared from an infinite number of grapes, ripe and seasonably gathered, in clusters, somewhat squeezed in the press, and lastly purged and clarified in the vessel,† whence it is no wonder if we differ from others.

124. It will also, doubtless, be observed of us, that ourselves have not proposed the true and best end or scope of the sciences (the thing we censure in others); as the contemplation of truth is of greater dignity and sublimity than all utility and greatness of works, whilst the long and solicitous dwelling in matter, experience, and the uncertainty of particulars, which we recommend, fixes the mind to earth, or rather sinks it into an abyss of confusion and perturbation, at the same time driving and keeping it aloof from the serenity and tranquillity of a much diviner state, that of abstract wisdom.

We willingly allow the force of this argument, and above all things endeavour after what it intimates and requires; for we would place a true model of the world in the human understanding, such as the world is found to be, and not such as any one's reason might make it. And this cannot be done without first very carefully dissecting and anatomizing the world. But for those ridiculous and mock models of worlds, which the fancies of men have formed in philosophies, we reject them absolutely,‡ and, therefore, let men well consider and understand the difference there is between the idols of the human mind and the ideas of the divine mind, the former being no more than arbitrary abstractions, but the other the true signatures of the Creator upon the creatures, as impressed and limited in matter, by true and exact lines;‖ and, therefore, truth and utility are here the very things required, and works should be more esteemed as they are pledges of truth than as they are useful in life.§

* The saying of Philocrates, when he differed from Demosthenes, viz. "Do not wonder, Athenians, that I differ from Demosthenes, for he drinks water and I drink wine."

† The allegory is not difficult to interpret. The spontaneous water of the understanding is the natural unassisted human reason, in the ordinary way of exercising its talent. The water drawn by the wheels of logic is chiefly such doctrine as we find in Aristotle, his commentators, and followers; but the wine of the author is the knowledge gained from a large number of attentive observations made upon nature, and a variety of careful experiments, or a Sylva of matter, collected with choice and judgement, ruminated upon in the mind, and somewhat digested, and formed into axioms and rules of practice.

‡ Such, suppose, as the categorical world of Aristotle, the world of Epicurus, the Platonical world, and, of later date, the Cartesian world, &c. almost every philosopher pretending to model the world in his own manner; or to shew, if he had been the creator, how wisely he would have made it. But to find out what the world is in itself, as the Author of Nature has made it, is the thing here proposed.

‖ Viz. things themselves, with their differences, relations, dependencies, &c.

§ Observe, that works, in the author's sense, being derived from a knowledge of nature, are proofs that nature is understood, so far as regards the work effected, for works cannot be performed without knowing how to perform them; and, though this be a valuable fruit of knowledge, yet it is not the only one, but the contemplation of the truth, hereby confirmed to the mind, raises in it that veneration which is due to the Author of Nature, and wherein the perfection of the human intellect seems to consist. To this purpose the author adds, in another place, if any one, delighted with the love

125. It may, perhaps, be likewise objected, that we are only doing what has been done before, that the ancients proceeded in the same way that we do, and, therefore, that we shall, probably, after all this struggle and striving, but at length come to some one or other of those philosophies which prevailed among the ancients; for, that they, in the beginnings of their contemplations, procured a large stock of examples and particulars, digested them into registers, common-place books, and titles, and thence composed their philosophies and their arts, thus pronouncing upon full discovery; that they added examples occasionally, by way of confirmation, and as a help to instruction, but thought it needless and burthensome to publish their notes, memoirs, and common-place books of particulars, herein following the example of builders, who, after they have erected an edifice, take down the ladders and scaffolding, and remove them from sight.

It is true, one cannot easily believe that the ancients should have proceeded otherwise, but, unless we forget what has been above delivered, this objection or scruple is easily removed: for, we confess that the ancients had a form of inquiry and discovery, and their writings shew it, but this form was no other than flying from certain particular examples, with the assistance of common notions, (and, perhaps, some favourite part of the received opinions,) to the most general conclusions or principles of the sciences, from the fixed and undisturbed truth whereof they drew out and proved inferior conclusions, by intermediate propositions, and built their arts of these materials; and, if new particulars and examples arose, or were produced, to oppose their established doctrine, they either made them square, by subtile distinctions or accommodated explanations of their own rules, or else in a gross manner struck them out by exceptions, at the same time laboriously and obstinately wresting and fitting the more tractable particulars of their own principles. We must add, that neither their natural history nor experience was any way such as the case required, and that their method of bounding at once to their most general conclusions was the bane of philosophy.*

126. It may also be objected, that, as we disallow a liberty of pronouncing and laying down sure principles, till, by intermediate steps, we shall have regularly come to the most universal conclusions, we patronize a suspension of the judgement, and bring all to a state of scepticism. The truth is, we intend and propose, not the art of doubting in general, but the art of doubting properly, for we do not detract from but administer to the sense, and do not despise but regulate the understanding; and it is better to know so much as is necessary, and yet not think ourselves to know all, than to think that we know all, and yet remain ignorant of that which is necessary.†

and veneration of contemplation, should think the frequent and honourable mention we made of works sounds harsh and disagreeable, let him assure himself that he acts contrary to his own desires; for, in nature, works are not only beneficial to life, but the token of truth; and, as it is justly required in religion that faith should be demonstrated by works, so it is congruous in natural philosophy that knowledge also should be shewn and demonstrated by works, for truth is more manifest and confirmed by the indication of works than by arguments, or even than by sense; so that the state and condition of men are improved by the very same means that improve the mind.—We therefore judge, that what we have said of the dignity and excellence of works and the end in view is not equal to but comes far short of the truth.—See Aph. 129.

* See Sect. I. and II. passim. † See the *De Augment. Scientiar.*

127. It may likewise be doubted, whether we speak only of perfecting natural philosophy in our manner, or of the other sciences also, as logic, ethics, politics, &c. Our answer is, that what we here deliver regards them all; and, as the common logic, which governs things by syllogism, belongs not only to the natural sciences, but to all, so our new logic, which proceeds by induction, comprehends every thing; for we design and draw up histories and tables of invention, 1. for the passions of anger, fear, modesty, and the like; 2. for models of government and civil affairs; and, 3. for the mental actions of the memory, composition, division, judgement, &c.; 4. for heat, cold, light, vegetation, &c.: but, as our method of interpretations, after our history shall be once procured and prepared, does not, like the common logic, regard only the motions and reasonings of the mind, but likewise the nature of things; so we conduct the mind in such manner as that it may, in every respect, properly apply itself to the nature of things; and, therefore, shall deliver many different precepts in the doctrine of interpretation, which may, in some measure, relate to the quality and condition of the subject inquired into and the manner of invention.*

128. But no one, sure, can suspect that we desire to destroy and demolish the philosophy, the arts, and the sciences, at present in use; for, on the contrary, we embrace their use, and willingly pay them all due honour and observance; and, indeed, we would no ways hinder them from being used in maintaining disputes, adorning discourses, and serving in the professory offices and short methods of acting in civil life; or, again, from being received, like coin, by the common consent of mankind, for we openly declare, that the things we offer are not very conducive to these purposes, as they cannot be brought down to vulgar capacities, otherwise than by effects and works; and how sincerely we profess this affection and good-will towards the sciences already received, our former attempt for their advancement may save us the trouble of repeating. But this we firmly and expressly aver, that, by the methods now in use, no great progress can be made in the contemplative and doctrinal sciences, nor they possibly be employed for the enlarging and extending of works.†

* A considerable part of this direction comes in the Second Part of this Work, and that the author extended his view, and fitted his new logic to the purposes not only of physics, but universal philosophy, and the whole body of arts and sciences, appears from his De Augmentis Scientiarum and Sylva Sylvarum, as well as from the present work, and the particular inquiries himself has begun, such as the History of Life and Death, the History of Winds, the History of Astronomy, the History of Philosophy, the History of Authors, Discourses of War, Government, Morality, Economy, &c. so that the method of working by tables and induction seems excellently fitted for the due and commodious prosecution of all kinds of inquiries.

† This seems the proper place wherein to insert and preserve a few Aphorisms belonging to the present subject, that were found scattered in other parts of the author's works.

"1. But if any one shall think it needless in us to bestow so much pains and diligence in preparing the minds of men, or imagine that we do it in some measure to shew our parts and learning, and had rather, without all circumlocution and preparatory discourse, be told the thing itself, directly, in few words;—we answer, that we could wish, for the good of mankind, this were the case, or that it were as easy to surmount the difficulties and remove the impediments in our way, as it is for us to lay aside empty pride and ostentation. But we desire mankind should know that we have had

129. It remains that we say something to the excellency of the end in view; which, if said before, might have seemed no more than a good

some experience of the way, in this great solitude we are entertaining, as the subject we have now in hand absolutely requires we should, and that we would by no means expose or betray such a subject through a want of skill to treat and deliver it. We must, therefore, assure them, from a thorough consideration and insight both of things and the minds of men, that we find it almost harder to gain access to the mind than to things, and that we find the labour and difficulty of delivering not much less than of discovering; so that we are here obliged to practise, what is almost a new thing in intellectual matters, complaisance or courtship, and at once to bear the load, not only of our own thoughts, but those of other men; for, the only way of subverting the idols of vanity is by approaching them obsequiously, and not by rushing in upon them with violence and fury.

2. "And this does not wholly happen from hence, that men are captivated with the admiration of authors, or swollen with their own conceits; or because, through custom and prejudice, they will not be impartial; for, though a man would very gladly impose a just and even temper upon himself, and, as it were, forswear all prejudice, yet even such a disposition of mind cannot be trusted; for, no man has a command over his own understanding, which depends not upon his will; nor is the spirit of the philosophers, any more than the spirit of the prophets, subject to those it reigns in; it is not, therefore, the equity, the sincerity, or the facility, of other men, but our own conduct, discretion, and condescension, that must secure us in our undertaking, and render it successful.

3. "And here, again, we lie under no small difficulty, on account of our own natural temper and manners, for it is an irrevocable decree with us ever to retain our native candor and simplicity, and not attempt a passage to truth under the conduct of vanity, but so to moderate and behave ourselves, as not by any artifice, craft, cunning, imposture, or any thing like imposture, but barely by the ornament of order, and by diligently engrafting new discoveries upon the soundest part of the old ones, to work our way and effect our design. So far, therefore, from labouring this point too much, that we rather judge we have bestowed less pains and diligence in preparing men's minds and conquering such great difficulties, than the nature of the design requires.

4. "It is observable that most men, in delivering or concealing their knowledge, do not deal sincerely, or as the nature of the thing demands; and, though the crime may be less, yet the mischief is the same in those who are of sound morals and approved candor, but want prudence or the art and method of delivering the things in their just order. Yet this unfair, ungenerous, or unskilful, manner of delivering the sciences, is not greatly to be complained of, as such writers have not, by their way of delivering, broke the force of the things they deliver; for, a perverse way of teaching is justly preserved where only trifles are taught; but, as our design is not to deliver the fictions of our own fancy, the sport of words, a mixture of philosophy and religion, nor certain popular observations or considerable experiments worked up into fabulous theories, but real nature, with all her fruits about her, we should think it a betraying of our trust to infect such a subject, either with an ambitious, an ignorant, or any other faulty manner of treating it. Our utmost study is, therefore, bent upon a just and proper method of delivering ourselves.

5. "Many will, doubtless, be inquisitive to know, what this just and proper method is, and require it to be told them naked and artless, without any preamble, that they may exercise their own judgements upon it, and we wish, indeed, matters were so well with them, that we might gratify their request. But the truth is, the minds of men have the same ways and passages up to them, so thick beset, and obstructed with such dark, deep-rooted, and inveterate, idols, as in no wise to be soon cleared, laid level, and polished, to receive the true and native images of things. Whence we are obliged to use our utmost address, to insinuate and slide into these dark and thick coverts; for, as lunatics are only to be cured by art and proper applications, but are rather made worse by force, opposition, and rough usage, the same course are we obliged to take and use a gentle method in the cure of this universal madness. And here we surely have a hard task to deliver science so innocently as to give no occasion of error and offence; yet, with such a native and implanted force as may procure credit, guard against the injuries of time, and deliver knowledge down to posterity, like a vigorous and lively plant, that may daily grow and increase, whilst, at the same time, we single out for ourselves, and, as it were, adopt a rightly-disposed and legitimate race of Readers: but whether we have done all this, must be left to the judgement of posterity."

wish; but now, when the grounds of hope are laid and unjust prejudices removed, it may, perhaps, have greater weight. If, indeed, we had perfected the whole design, and did not desire others to share the labour with us, we would have dropped every thing of this kind, lest it should be taken for publishing our own merit; but, as an edge must be given to the industry of others, and their minds be excited and raised, it is proper we should here admonish mankind of a few particulars; and, first, the introduction of noble inventions seems to hold by far the most excellent place among all human actions. And this was the judgement of antiquity, which attributed divine honours to inventors, but conferred only heroical honours upon those who deserved well in civil affairs, such as the founders of empires, legislators, and deliverers of their country; and whoever rightly considers it will find this a judicious custom in former ages, since the benefits of inventors may extend to all mankind, but civil benefits only to particular countries, or sects of men; and these civil benefits seldom descend to more than a few ages, whereas inventions are perpetuated through the course of time. Besides, a State is seldom amended in its civil affairs, without force and perturbation, whilst inventions spread their advantage without doing injury or causing disturbance.

Discoveries also are like new creations and imitations of the divine works; and it is observable of Solomon, that he fixed not his glory in any of the privileges of royalty or other excellencies whereof he was possessed, but in this single business of invention. "It is the glory "of God, (says he,) to conceal a thing, and the glory of the king to "find it out."

Again, let any one consider what a difference there is betwixt the life led in any polite province of Europe, and in the savage and barbarous parts of the West-Indies, and he will find it so great that one man may deservedly seem a god to another, not only on account of greater helps and advantages, but also upon a comparison of the two conditions, and this difference is not owing to the soil, the air, or bodily constitution, but to arts.

Again, it may not be improper to observe the power, the efficacy, and the consequences, of inventions, which appear no where plainer than in those three particulars, unknown to the ancients, and whose origins, though modern, are obscure and inglorious, viz. the art of printing, gunpowder, and the compass, which have altered the state of the world, and given it a new face, 1, with regard to learning; 2, with regard to war; and 3, with regard to navigation; whence numberless vicissitudes of things have ensued, insomuch that no empire, no sect, no celestial body, could seem to have a greater efficacy, and, as it were, influence over human affairs than these three mechanical inventions have had.

Again, it may not be amiss to distinguish three kinds, and, as it were, degrees of ambition in mankind; — the first, that of such as desire to aggrandize their private power in their own country, which is the most vulgar and degenerate; the second, of such as endeavour to enlarge the power and empire of their country, in respect of others, which is more noble, though no less cupidinous; but, if any one should strive to restore and enlarge the power and empire of mankind over the universe of things, this ambition (if it deserves the name of ambition) is, without dispute, more solid and majestic than the others. But the empire of man over things is entirely founded in arts and sciences, for nature cannot otherwise be commanded than by obeying her laws. But

if the utility of any particular invention can affect mankind so much as to make them think him more than human, who could, by any single benefit, oblige the whole species, how much more noble must it appear, to discover some one thing, by which all others may readily be discovered?* And yet, to say the truth, as we are greatly obliged to light, because by its means we can see to read, find our way, exercise our arts, and distinguish one another, whilst the sight of the light itself is a more excellent and beautiful thing than these its various uses, so, without dispute, the contemplation of things, as they are in themselves, without superstition or imposture, error or confusion, is itself of greater dignity than all the benefits of invention.†

If any one, in the last place, should object that the arts and sciences may be wrested, and turned to evil purposes, or sin, luxury, &c. this can have little weight, because it may be said of all the best things in the world, such as great capacity, courage, strength, beauty, riches, light itself, &c. Let but mankind recover their right over nature, which was given them by the Divine Being, let them be well provided of materials, and rectified reason and sound religion will direct the use.‡

130. It is now time we should propose the art of interpreting nature, wherein, though we conceive that we have laid down highly useful and just precepts, yet we attribute no perfection or absolute necessity to this art of our's, as if nothing could be done without it; for it is our opinion, that, if men were possessed of a just history of nature and experience, were thoroughly versed therein, and could command themselves but in two particulars, the one in laying aside received opinions and notions, the other in withholding the assent, for a season, from general conclusions, they might, by their proper and native force of mind, without any other art, fall upon our form of interpretation; for the whole is no more than a genuine and natural work of the mind, when the obstacles to it are removed, though all will be made readier for use and receive great strength by our precepts.

* Viz. A new machine, or logic, directing the mind to act upon all subjects with great advantage. This discovery the Author, in another place, compares to the discovery of the compass, thus,—"As in former ages, when navigation was directed barely by observing the stars, men could do no more than coast it along the shores of the old world, or cross some narrow seas, whilst the use of the compass was required, before the great ocean could be traversed, and the new world be discovered; in like manner the present discoveries in arts and sciences might be made by instinct, experience, observation, and contemplation, as lying not very remote from sense; but, before the deeper and more remote parts of nature can be laid open, a better and more perfect way of using and working with the mind is necessarily required." — He farther observes that "the new world of knowledge differs from the new world of America, the former being much better furnished with arts than the latter, so that the known arts of Europe are great things there, whereas, on the contrary, the additions still required to the arts in use must be of a higher kind, and so effectual as to bend, subdue, and conquer nature, or affect her radically, for it almost constantly happens that the things easy to find prove but of little service, whilst the roots of greatest virtue and efficacy are deepest buried."

† See Aph. 124.

‡ Perhaps it is not easy to form any considerable objection to the present design, besides those that have been already answered. However, if any remain, they have a right to be proposed, even though derived, as possibly all the above-mentioned are, from anticipation, or the common, imperfect, and hasty, use of the rational faculty. Upon a retrospection, those that have been produced appear chiefly personal, and are answered accordingly by arguments *ad hominem*, that do not directly affect the main of the question, only tend to molify and assuage men's minds, and allay the winds of prejudice and hasty opposition.

Nor do we say that nothing can be added to these precepts of our's: on the contrary, we, who do not highly esteem the mind in its own faculty, but chiefly so far as it is furnished and joined with things, ought to lay it down, that the art of invention may grow up with inventions themselves.*

* The Author's Piece, entitled *Cogitata et Visa*, which was a rough draft of this first or preparatory part of the Novum Organum, concludes thus: — "The matter we have in hand is not an opinion, but a work, and not designed to lay the foundations of any sect or partial doctrine, but to prove generally and extensively useful, whence it has required the greater care and consideration, not only with regard to the perfecting of the thing itself, but also with regard to the manner of delivering and communicating it; for, it is commonly found, that men have views to fame and ostentation, sometimes in concealing and sometimes in uttering the knowledge they think they have acquired. And those, also, who have things but of little weight to offer, usually describe and put them off in half lights, the better to serve and humour their own vanity. But for our undertaking, we judge it of such a nature that it were highly unworthy to pollute it with any degree of ambition or affectation; and yet, unless we were greatly unskilled in the nature of men's minds and of things, and desired to enter the road at once, without making the least trial thereof, it lies upon us to remember, that inveterate errors can only be rooted out by art and gentle treatment; and that, therefore, a certain prudence and compliance must be used, so far as may comport with candor and simplicity, in order to prevent opposition before it is made. And, for this purpose, we are preparing a philosophical work, that may have a quiet and agreeable access to the senses of men; and this, we hope, will prove the easier, because we do not propose ourselves as leaders, but derive and scatter light from nature herself, so that there shall hereafter be no occasion for leaders; but time, in the interim, being on the wing, and the Author too much engaged in civil affairs, especially considering the uncertainties of life, he would willingly hasten to secure some part of his design from contingencies; and, after much close thought, and a deliberate consideration, he determined, that, to prevent so useful a thing from disaster, the best course was to propose and lay down certain tables of invention, or forms of genuine inquiry, that is, the digested matter of particulars, designed for the work of the understanding, and this in some determinate subjects, by way of example, or a palpable model of the whole. Nor could he devise any thing better for setting the true manner of procedure and the errors of the way in a clear light, or for evidently shewing that the things delivered are solid, and not the sport of words; and, again, for distinctly pointing out what they should avoid who either distrust the design or conceive too highly of it; and hence, though we should not ourselves complete the undertaking, yet men of a solid and sublime genius, being thus admonished by what we have offered, may, without any greater assistance, expect the rest from themselves, and finish it; for, as to the matter in hand, we are almost of his opinion, who said, 'this is enough for the wise, and, for the unwise, more would not be serviceable;' but, as it would have appeared too abrupt to have begun with the tables themselves, we thought proper to introduce them by this preparatory discourse."

PART II.—SECTION I.

PARTICULAR APHORISMS FOR INTERPRETING NATURE, OR, THE MEANS OF ENLARGING THE HUMAN POWER AND KNOWLEDGE, BY THE DISCOVERY OF FORMS.

APHORISM I.

1. It is the office and end of the human power to generate or superinduce a new nature or natures upon a body assigned; and, 2, the office and end of the human knowledge, to discover the form of a nature assigned, that is, its real difference, naturizing nature, law, or the fountain whence it flows, which are terms we use in order to give some tolerable notion of our meaning;* and, subservient to these two primary works, there are two other secondary ones of inferior consideration, thus, 1, to the former belongs the transformation of concretes, from one thing into another, through all possible variety; and, 2, to the latter, the discovery of the latent process in every generation and motion, as it is continued from the manifest efficient, and the manifest matter, up to the giving of the form; and, in like manner, there belongs to it the discovery of the concealed structure of quiescent bodies, or bodies that are not in motion.†

2. How inadequate and unsuccessful that human knowledge is which we have at present in use, may appear from the things commonly asserted.‡ It is certain that true knowledge is the knowledge of causes. Now we may properly make four kinds of causes, viz. 1, the matter; 2, the form; 3, the efficient; and 4, the end.—But the latter, or final cause, is so far from being serviceable, that it corrupts the sciences, unless it be restrained to human actions. The discovery of forms is held desperate; and the efficient and material causes, in the manner they are at present sought after and admitted, (viz. the remote efficient and the remote material causes, without the knowledge of the latent process up to the form,) are trifling and superficial things, that scarcely at all contribute to real and effective knowledge. It is true, we above

* For a fuller notion of forms, see Aph. 2, 17, 20, and Sect. II. Aph. 23, 27, &c. but, to render this Aphorism more clear and intelligible, we may turn it thus:—"Upon a given basis of matter, to form or introduce a new nature, in all possible cases, is the use and exercise of our powers, and to discover the causes of the effects in all subjects is the use and exercise of our knowledge, which are two coincident intentions and in effect the same; for, what in speculation appears to be the cause, is, in practice, the means of action, and directs us in the performing the thing. Thus, for example, upon finding that the specific and determinate virtues, or tastes and odours, of certain aromatic plants, reside in their essential oils, we are hence directed to obtain these oils, in order to procure the peculiar virtues, tastes, and odours, of such plants. And thus the case holds universally, as will more fully appear hereafter."—See Aph. 3, 4, 11, 12, &c.

† The present set of Aphorisms will require a considerable degree of attention, and should be read in the manner of mathematical demonstrations.

‡ Which are seldom found, upon farther inquiry, to be derived from their causes, so that they frequently fail when used as rules of practice.—See the First Part passim.

noted and corrected the error of the mind, in attributing the essences of things to forms;* but, although in nature nothing really exists besides individual bodies that perform individual actions by a law, yet, in doctrine, this law itself, the inquiry into it, with the discovery and explanation thereof, is the foundation as well of knowledge as of works, and it is this law and its parts that we understand by the name of forms,† especially as the term already prevails, and is grown familiar.‡

3. He who knows the cause of any nature, as for instance, that of heat, or whiteness, in certain subjects only, has an imperfect knowledge;—he who can produce an effect upon certain matters only, among those susceptible thereof, has, in like manner, an imperfect power, and he who knows only the efficient and material causes,‖ which are unstable, and in some cases no more than vehicles, or causes that carry the form, may arrive at new inventions on a subject somewhat similar and prepared, though he cannot remove the boundaries of things that are deeper fixed; but he who understands forms will perceive the unity§ of nature in the most dissimilar cases, and may, therefore, discover and produce such things as have not hitherto appeared, or such as neither the vicissitudes of nature, nor the industry of experimenting, nor chance itself, could ever have brought into being, nor would they otherwise have entered the thoughts of men.** So that justness of theory or contemplation, and freedom of practice, or operation, depend upon the discovery of forms.

* See Aph. 51.

† By the word forms, therefore, we are to understand a full and clear knowledge of the law, procedure, or means of nature, in producing effects. This notion will, however, be farther improved and explained hereafter. See Aph. 17, 20.

‡ The Author every where endeavours, as much as possible, to retain the ancient terms, though he conveys new meanings under them, as judging it best to innovate, like time, by degrees.

‖ See Aph. 2, of this Part.

§ Viz. The uniformity, or rather the identity, or sameness of nature; for, by the supposition, forms are the laws of nature, according to which she constantly acts, that is, ever in one and the same manner, so that a knowledge of forms is a knowledge of the unity, identity, or what may be called the manner, of nature.

** In another place, the author has broken this Aphorism into parts, which may render it more intelligible, viz.

1. "He who understands the cause of any nature in certain subjects only has but an imperfect knowledge, as he, who can produce an effect only in one certain matter of all those susceptible thereof, has but an imperfect power.

2. "He who understands efficient and material causes is thence instructed how to compound, divide, transfer, or produce, and even proceed to new discoveries, in subjects of a somewhat similar and disposed matter, but cannot by this means alter the deep-fixed limits of things.

3. "He who understands the causes of any nature but in certain subjects knows only the efficient or material causes, which are unstable things, and no more than vehicles of causes, wherein the form resides; but he who understands the uniformity of nature, in very different kinds of subjects, has a knowledge of the forms of things.

4. "He who understands forms will discover and produce such things as are hitherto unknown and unproducted, and such as neither the revolutions and changes of nature nor experience would ever have manifested, nor the thoughts of men ever otherwise have conceived.

5. "The way and perfection of truth and power is the same, viz. the discovery of forms, upon which ensues both a just theory and an unlimited practice. And hence it appears, that the perfection of human knowledge, both speculative and practical, is the knowledge of forms; for, to contemplate the process of nature in her works, is a just theory, that leads to a perfect practice." No wonder, therefore, if the discovery of forms be the sole business of this Second Part of the Novum Organum.

4. Although the human power and human knowledge are nearly allied, and, in a manner, the same, yet, by reason of the pernicious and inveterate custom of dwelling in abstract notions, it is abundantly the safest way to begin and build up the sciences from those foundations which are laid in order to practise, so as to let this mark out and determine the theory. We shall, therefore, here examine what kind of rule, directions, or leading, a man would principally wish for, in order to superinduce an assigned nature upon a given body. — Thus, if any one should desire to superinduce upon silver the yellow colour of gold, and to increase its specific gravity, or to superinduce transparency upon an opaque stone, malleability upon glass, vegetation upon a body not of the vegetable kind, &c. he would, doubtless, desire to be shewn, (1.) some way that should not frustrate his labour, or fail him upon the trial. (2.) He would desire such a method as should not tie him down or confine him to the use of certain determinate means and particular ways of working, because he might, perhaps, be provided herein, or not have the power and convenience of procuring the necessary helps; and, if there were other methods within his power, besides that delivered in the rule, for superinducing such a nature, that he might not be excluded their use, through the limitation or narrowness of his rule, and so not receive the benefit of those methods. (3.) He would wish to be shewn something less difficult than the operation he inquires after, and such as might approach nearer to practice.—The precept, therefore, for a true and perfect practical rule is, that the rule be sure, unrestrained to particular means or expedients, and dispose or lead directly to action, and this is the same thing with the discovery of a real form; for, the form of any nature is such, that where it is, the given nature must infallibly be; — the form, therefore, is perpetually present when that nature is present, ascertains it universally, and accompanies it every where. Again, this form is such, that, when removed, the given nature infallibly vanishes: therefore, the form is perpetually wanting when that nature is wanting, and thus confirms its presence or absence, and goes and comes with that nature alone.—Lastly, a true form* is such as can deduce a given nature from some essential property,† which resides in many things, and is more intimately known or linked to nature than the form itself. — The precept, therefore, for a true and perfect theoretical axiom, is to find another nature that may be convertible with the nature assigned, yet limit the common nature, like a true genus.‡—These two precepts, the former whereof is practical and the latter speculative, are one and the same thing;‖ and so what proves most useful in practice is also perfectly just in theory.§

* Viz. a knowledge of nature's means, in producing any effect.—See Aph. 3 of this Part.

† To find this property, therefore, readily disposes and leads to practice, by singling out one particular property, whereon the rest depend, instead of pursuing a great many. Thus, it should seem, that if any matter could be made as ponderous as gold, it would become gold; or, if any matter could be made as hard and resplendent as the diamond, it would become diamond, &c.

‡ So, for example, by inquiring into the form of heat, a particular shuddering motion among the small parts of bodies seems the convertible nature, or form, that, like a true genus, limits the more common nature of heat.—See Aph. 15, 16, 17, 18, &c. but particularly Aph. 20.

‖ See Part I. Aph. 3.

§ The meaning is, that, to gain the best practical rules, we must discover the forms of things; that forms are rules, and theory and practice the same thing. The following Aphorisms will add more light hereto. See in particular Aph. 9.

5. But the rule, or axiom, for the transmutation of bodies,* is of two kinds: the first regards a body as a certain collection or combination of simple natures:† — thus, for example, in gold, there meet together yellowness, a determinate gravity, malleability to a certain degree, fixedness in the fire, a particular manner of flowing in the fire, a determinate way of solution, &c. which are the simple natures in gold; and, therefore, this kind of axiom deduces the thing from the forms of simple natures, for he who understands forms, and the manner of superinducing this yellowness, gravity, ductility, fixedness, faculty of fusion, solution, &c. with their particular degrees and proportions, will consider and provide how to join them together in some body, so that a transmutation into gold shall follow, and this kind of operation regards the principal action: for the way is the same of producing any one simple nature as many, only man is more confined and restrained in working where many are required; because of the difficulty of uniting a variety of natures together, which do not easily meet, except in the common and beaten roads of nature;‡ and yet this method of working, which regards simple natures, though in a concrete body, may proceed upon such principles as are constant, eternal, and universal, in nature, and afford such broad ways to the human power as the mind, in the present state of things, can scarcely conceive or represent to itself.‖

But the second kind of axiom, which depends upon discovering the latent process,§ does not proceed by simple natures, but by concrete bodies, such as they are found in the ordinary course of nature; — for example, when inquiry is made from what origin, by what means, and what procedure, gold, or any other metal, or stone, is generated from its first fluid matter, or rudiments, up to a perfect mineral; or, again, by what process plants are generated, from the first concretions of their juices in the earth, or from the seed to a formed plant, together with the whole succession of motion, and the various and continued endeavours of nature. Understand the same of regularly explaining the production of animals, from the first act of generation, and so of other bodies.**

And this inquiry does not only regard the generation of bodies, but likewise other motions and works of nature; for example, when inquiry is made into the whole series and continued actions of nutrition, from the first receiving of the aliment to a perfect assimilation; or, after the same manner, into the voluntary motion of animals, from the first impression of the imagination, and the continued efforts of the spirit, down to the bending and moving of the limbs; or, again, in explaining the motion of the tongue, lips, and other organs, up to the formation

* See Aph. 1. of this Part.

† Or what we commonly call properties.

‡ Viz. As they are united by nature herself, for example, in gold, quicksilver, &c.

‖ There are several attempts of this kind in the *Sylva Sylvarum*. See particularly the articles gold, transmutations, &c. But a more perfect history of nature and art must be procured, before any successful method of this kind can be formed.

§ Viz. The several continued steps, or whose procedure of nature in producing effects.—See Aph. 6.

** Let an eye be had all along to the first Aphorism of this section, where a foundation of the whole is laid.

of articulate sounds; for, these things also have regard to concrete natures, or natures associate and organical; and belong, as it were, to the particular and especial customs of nature, and not to the fundamental and common laws which constitute forms. It must, indeed, be allowed, that this method seems more facile, quick, and promising, than the primary method above mentioned.*

But the effective part, which answers to this speculative one, in like manner, extends and advances its operation, from those things which are commonly found in nature, to certain others that lie near, or not very remote, though the higher and radical operations upon nature require the former primary axioms; and, where mankind has no power of operating, but only of contemplating, as in the celestial bodies, which we cannot operate upon, change, or transform; yet the inquiry of the fact, or truth of the thing, belongs, no less than the knowledge of causes and relations, to the primary and universal axioms of simple natures;† suppose, for example, the inquiry about the nature of spontaneous rotation, attraction, and many other natures, which are more common and familiar to us than the celestial bodies themselves, and let no one expect to determine the question whether the diurnal motion belongs to the heavens or the earth, unless he first understand the nature of spontaneous rotation.‡

6. The latent process we speak of‖ is a thing that cannot easily enter the mind, so beset as it is at present; for we do not here mean certain visible measures, or signs, or steps of procedure in bodies, but a perfect continued process, the greatest part whereof escapes the sense.

Thus, for example, in every generation and transformation of bodies, it comes to be inquired what is lost or flies off, what stays behind, what is added, what dilated, what contracted, what united, what separated, what continued, what cut off, what impels, what obstructs, what prevails, what yields, &c.

Nor are these things only to be sought in the generation or transformation of bodies; but, after the same manner, it comes to be inquired in all other alterations and motions, what precedes, what succeeds, what is quick, what slow, what gives motion, what governs it, and the like; but all these things remain unknown and untouched in the sciences, which are at present formed in a very gross and perfectly inadequate manner; for, as every natural action is performed by the smallest particles, or at least by particles so small as to escape the senses, let no man expect to govern nature, or turn her course, till he has, in a proper manner, become acquainted with these small particles.

7. Again; the inquiry and discovery of the concealed structure in bodies is as much a new thing as the discovery of the latent process and form, for men have hitherto trod only in the outer courts of nature, and are not prepared to enter within. But no one can superinduce a new nature upon a given body, or successfully and appositely change into another body, unless he has first a competent knowledge of the body to be altered or transformed, as without it he will fall upon frivo-

* See § 7, and again Aph. 7.

† See § 7.

‡ Because the more simple, common, and obvious, natures must be understood, before we can hope to understand such as are compounded, remote, or abstruse.

‖ See Part II. Aph. 1.

lous methods, or at least such as are difficult, perverse, and unsuitable, to the nature of the body whereon he operates, and therefore, in this respect also, a way must be necessarily opened and prepared.

Labour is properly and advantageously bestowed upon the anatomy of organical bodies, such as those of men and brutes, as it seems a thing of subtilty and a good scrutiny of nature. But this kind of anatomy is a work of the eye, subject to sense, and takes place only in organical bodies; so that it is an obvious and facile thing, compared with the real anatomy of the latent structure in bodies accounted similar, especially in specificate things and their parts, as iron and stone, the similar parts of plants and animals, as the root, leaf, flower, flesh, blood, bone, &c.; and, in this particular, human industry has not been entirely wanting, as appears from the separations of supposed similar bodies by distillations and other methods of solution, in order to shew the dissimilarity of the compound, by separating and collecting its different homogeneous parts together, which is a thing of use, and makes to our present purpose, though it is often fallacious, because many natures are attributed to separation, as if they pre-existed in the compound, whilst they are really given and originally superinduced by the fire, heat, or other method of resolving them. And this also is but a small part of the business of finding the true structure of a compound, as this structure is a thing of very great delicacy and subtilty, and rather confounded than discovered and brought to light by the operations of the fire.*

Bodies, therefore, are to be separated and resolved, not by fire but by reason and genuine induction, with the assistance of experiments; and again, by comparing them with other bodies and reducing them to simple natures and their forms, which meet and are combined in the compound; for, we must go over from Vulcan to Minerva, if we would bring to light the real textures and structures of bodies, wherein all the secret and specific properties and virtues of things depend, and whence the rule of every powerful alteration and transformation is to be derived.

Thus, for example, we must inquire what the spirit in every body is, and what the tangible substance, whether this spirit be copious and turgid, or hungry and small in quantity,—whether it be thin or gross, airy or fiery, brisk or sluggish, weak or strong, in progress or recess, interrupted or continued, agreeing or disagreeing with the things external and circumjacent, &c.—And in like manner we are to inquire about the tangible substance (which admits as many differences as the spirit); what its coats, its grain and fibres, its kind of texture. Again, under the same inquiry comes the distribution of the spirit through the corporeal mass, with its pores, passages, veins, cells, and the rudiments or first lineaments of the organical body; in which cases also, and consequently in the investigation of every concealed structure, a true and clear light is afforded, by our primary axioms, sufficient to dispel all darkness and useless subtilty.†

8. Nor will this bring us to the hypothesis of atoms, which erroneously pre-supposes vacuity and a permanent state of mattter, but to

* The fire is a very improper analyser in many cases, especially where the subject is capable of being scorched, or rendered empyreumatic, which quite perverts or alters its nature, as we see in burnt sugar, &c.

† See Part II. Aph. 1, 5, and 7.

real particles such as they are found; nor need any one dread this subtilty as inexplicable;* for, on the contrary, the more the inquiry tends to simple natures, the plainer and clearer will every thing become, the business being thus brought from multiplicity to simplicity, from incommensurables to commensurables, from surds to computables, and from things finite and vague to such as are definite and certain, as in the case of the letters of the alphabet and the notes of music.† And it is then that a natural inquiry proceeds justly, when physical considerations terminate in such as are mathematical.‡ And again, let no one be frighted at multitude or fractions; for, in things performed by numbers, it is as easy to set down or think of a thousand as of one, or of the thousandth of a unit as of a unit itself.

9. From the two kinds of axioms above laid down arises a just division of philosophy and the sciences, taking the received terms (which come nearest in expressing the thing) agreeably to our own meaning, viz. so that the inquiry of forms, which, from the reason of the thing itself, and their own law, are eternal and immutable, may make metaphysics; and the inquiry into the efficient, the matter, the concealed process, and latent structure, may constitute physics, as these several particulars regard the common and ordinary course, and not the fundamental and eternal laws of nature;—and let each have its corresponding branch of practice, and mechanics be made subservient to physics and magic (taking that word in its genuine sense) to metaphysics, on account of the wide passage which magic affords into, and the great command it has over, nature;‖ and, having thus established the scope and end of our doctrine, we proceed, in a regular manner, to precepts.§

10. The indications for the interpretation of nature include two general parts; the first relates to the raising of axioms from experience, and the second to the deducing or deriving of new experiments from axioms.** The first is divided into three kinds of administrations, or

* This caution appears to be seasonably interposed; for, doubtless, many readers, who have not been used to abstruse speculations or mathematical reasoning, will be at a loss to perceive what the Author drives at, or be apt to imagine the whole an intricate subtilty, not worth the trouble of understanding. Those, who think in this manner, may please to pass over for a time the first ten Aphorisms of this Second Part, and begin with the eleventh; for, the practical tables and actual method of investigating the forms of things (where all is performed by examples and sensible representations) will prepare the mind and facilitate the understanding of these more abstruse Aphorisms, if read after some tolerable notion of the business in hand, and the method of conducting it, is procured.

† For, as all the variety of sounds and words are made out of twenty-four letters, and all the variety of tunes out of eight notes, so a few simple natures, or primary properties, (such as fluidity and firmness, volatility and fixedness, &c.) appear to compose all that variety which we find in bodies.

‡ For, all the motions, powers, forces, operations, energies, and quantities, of bodies, must be computed, measured, and determined, before natural philosophy can be perfected. But let not the calculation be rashly applied, before the facts are discovered and ascertained, for mathematics is not to constitute but only to limit physics.

‖ This division appears extremely just and useful, but has not, perhaps, been any way considered and regarded as it deserves, on account of the imperfect state of philosophy; for, as philosophy improves, this division must, almost of necessity, take place.

§ The nine preceding Aphorisms are a kind of close-wrought axiomatical chain of doctrine, that, when rightly understood, will appear deep, sagacious, and drawn from nature, so as to lay a firm, just, and adequate, foundation for the intended new logic, or method of investigating the forms of things.

** This deriving of new experiments from axioms is a part of the present work that was not published.—See Aph. 21.

helps, viz. the helps 1, for the sense; 2, for the memory; and, 3, for the reason.

(1.) Therefore a just and adequate natural and experimental history is to be procured, as the foundation of the whole thing, for we are not to fancy or imagine, but to discover, what are the works and laws of nature.

(2.) But natural and experimental history is so copious and diffusive a thing as to confound and distract the understanding, unless such history be digested and ranged in proper order; therefore, tables and subservient chains of instances are to be formed and digested in such a manner, that the understanding may commodiously work upon them.

(3.) And, though this were done, yet the understanding, left to itself and its own spontaneous motion, is unequal to the work, and unfit to enter upon the raising of axioms, unless it be first regulated, strengthened, and guarded; therefore, in the third place, genuine and real induction must be used as the key of interpretation; but we are to begin at the end and proceed backwards to the rest.*

The inquiry of forms† proceeds in this manner:—first, all the known instances agreeing in the same nature, though in the most dissimilar subjects, are to be brought together and placed before the understanding; and this collection is to be made historically, without any overhasty indulgence of speculation, or any great subtilty for the present. We will illustrate the thing by an example in the inquiry into the form of heat.

TABLE I.

THE TRUE METHOD OF DISCOVERING FORMS, ILLUSTRATED BY AN EXAMPLE IN THE FORM OF HEAT.

Instances agreeing in the nature of Heat.‡

(1.) The sun's rays, especially in summer and at noon-day.

(2.) The reflex and collected rays of the sun, as betwixt mountains and walls, but particularly in burning-glasses.

(3.) Fiery meteors.

(4.) Burning lightning.

(5.) Eructations of flame from the caverns of mountains, &c.

(6.) Flames of all kinds.

(7.) Ignited solids.

(8.) Natural hot-springs.

(9.) Heated fluids.

(10.) Hot vapours and fumes, and the air itself, which conceives a violent and raging heat, when pent up, as in reverberatory furnaces.

(11.) Certain clear sultry seasons, from the constitution of the air, without regard to the time of year.

* That is, we are to begin with induction, and proceed backwards to the forming of a natural and experimental history, and then to the forming of axioms, &c.

† Whereon the advancement and perfection of philosophy, the sciences, and all practical arts depend, as has been shewn before, Aph. 1—7.

‡ Viz. A collection of the particulars wherein heat is found, so that the following particulars agree in having the nature of heat common to them all.

(12.) Subterraneous air, confined in certain vaults or caves, especially in the winter.

(13.) All shaggy matters, as wool, the furs and plumage of animals, have some degree of warmth.

(14.) All bodies, as well solid as fluid, dense as rare, even the air itself, exposed to the fire for a season, become hot.

(15.) The sparks caused by a strong percussion betwixt the flint and steel.

(16.) All bodies upon a strong attrition, as stone, wood, cloth, &c. whence the axletrees and wheels of carriages sometimes take fire; and it has been a practice to procure fire by attrition in the West-Indies.*

(17.) Green and moist plants, laid up and pressed close together, as roses, pease in carts, &c. so likewise hay stacked before it is dry often takes fire.†

(18.) Quick lime slaked with water.

(19.) Iron, when first dissolved with acid spirits, though contained in a glass, without any assistance of the fire; and, in like manner, tin, &c. though not so intensely.

(20.) Animals, especially their inward parts, though in insects, by reason of the smallness of their bodies, no heat is discoverable to the touch.

(21.) Horse-dung, and the like recent excrements of animals.

(22.) Oil of vitriol, aqua fortis, &c. have the effects of heat in burning linen, &c.

(23.) The essential oil of origanum and the like have the effect of burning the teeth.‡

(24.) Well-rectified spirit of wine has the effect of heat, so as to blanch and harden the white of an egg put into it, almost like boiling water; it also hardens or scorches, as it were, bread that is suffered to lie therein.

(25.) Spices and spicy herbs, such as dragons, old cresses, &c. though not hot to the hand, either whole or in powder, yet, when chewed a little, are found hot or burning to the tongue and palate.

(26.) Strong vinegar, and all acids, cause a pain not greatly differing from that produced by heat, when such acids are applied to any part of the body that is not defended by a scarf-skin, as the eye or tongue, for example, that are naked, or any other part that is wounded and laid bare.

(27.) Even a severe and intense cold produces a sensation like that of burning.‖

(28.) Instances forgot or omitted.§

* Viz. By rubbing two sticks together in a particular manner.

† See Boerhaave's Chemistry, process 88. on the Putrefaction of Vegetables. See also the Paper of Dr. Cox upon the same subject in the Philosophical Transactions.

‡ All the essential aromatic oils seem heating and inflaming to the body, particularly the oils of cinnamon, cloves, cortex winterans, &c.

‖ —— *Boreæ penetrabile frigus adurit.* Thus the handling of snow or ice will make the fingers glow.

§ Observe that this table is here only to serve as an example, and not as an actual inquiry prosecuted to its due length.

And this Table we call the Presenting or Affirming Table.*

12. In the second place, those instances are to be brought before the understanding, which have not the nature assigned, because the form, as we said, ought no less to be wanting, where the given nature is wanting, than to be present where that is present; but, as it would be endless to pursue these instances throughout, negatives are to be subjoined to the affirmatives, and the want of the given nature to be considered only in such subjects as are nearest related to those wherein it resides and appears. And this Table we call the Table of Declination, or of Absence in Approach.†

TABLE II.

INSTANCES OF APPROXIMATION, YET WANTING THE NATURE OF HEAT.

The first Negative, or Subjunctive Instance, to the first Affirmative.

(1.) The rays of the moon, stars, and comets, are not found hot to the touch, and the sharpest colds are observed in the full of the moon. ut, when the sun is in conjunction with the larger fixed stars, or approaches near them, such stars are thought to augment the heat, as when, for example, the sun is in Leo during the dog-days.‡

A second Negative Instance to the second Affirmative.

(2.) The rays of the sun heat not in that called the middle region of the air, and the reason commonly assigned with some probability for it is, because the body of the sun that emits the rays never sufficiently approaches either that region or the earth, which immediately reflects them, and this appears from the tops of mountains, unless extremely high, where the snow continually lies; but, on the contrary, it is observed by some, that no snow is lodged on the top of the pike of Teneriffe, and the Andes, or high mountains of Peru, but only upon the lower declivities;—besides, the air on the tops of these mountains is not found cold, but only thin and sharp, so as on those of Peru, to prick and vellicate the eyes, and mouth of the stomach, and cause a vomiting by their acrimony; and, it is observed by the ancients, that the air was so thin on the top of Mount Olympus as to make it necessary for such as went up, to carry along with them spunges dipped in vinegar and water, and every now and then apply them to the mouth and nose, because the air, through the great degree of its rarifaction, was not there sufficient for respiration.‖ And on the top of this moun-

* Because it exhibits the facts, or shews in what subjects the nature inquired after resides.

† Because it exhibits those particulars, wherein, through nearness, or apparent similarity, the given nature might be expected, and is yet found to be wanting: — thus, as the rays of the sun are found hot, the mind is apt to infer the same, in a less degree, of the rays of the moon; but the rays of the moon have no sensible heat, though they are the very rays of the sun by reflection.

‡ It might be proper in practice, or when any particular inquiry is gone upon, to write these Tables in opposite columns, on the same paper, which would render the whole more commodious and ready for use.

‖ Will this expedient, in any respect, supply the want of air for respiration?

tain there was said to be so great a serenity and tranquillity from rain, snow, and wind, that the letters drawn by the fingers of those who sacrificed there upon the altar of Jupiter, would remain in the ashes of the sacrifice, unaltered, till the year ensuing. And at present, the persons that go up to the top of Teneriffe, travel by night, not by day, and soon after sun-rising are advised and pressed by their guides to make haste down, for fear of being rendered breathless by the thinness of the air.*

A third Negative to the second Affirmative.

(3.) The reflection of the sun's rays, in the parts near the polar circles, is found exceeding weak and faint in point of heat, so that the Hollanders, who wintered in Nova Zembla, expecting, by the beginning of July, their ship to be freed from the mass of ice wherein she was frozen, found themselves disappointed, and were obliged to commit themselves to their long-boat; therefore, the direct rays of the sun seem to have little power, even upon a flat surface; and so have the reflex rays also, unless multiplied and united, as they are when the sun becomes more perpendicular, because the rays then strike in acuter angles, and so come nearer to one another, whilst, in great obliquities of the sun, the angles are very obtuse, and, consequently, the rays at a greater distance one from another. It must, however, be observed, that there may be many effects of the sun's rays, and such as participate of the nature of heat, which are not proportioned to our sense of touch, so that, with respect to us, they produce no warmth, though, with respect to some other bodies, they may have the effect of heat.†

A fourth to the second.

(4.) Let this experiment be made:—take a glass, fashioned in a contrary manner to that of a common burning-glass, and place it between the hand and rays of the sun, in order to observe whether it diminishes the sun's heat as a burning-glass increases it.‡ For, it is manifest, with regard to the optic rays, that, according as a glass is made of a different thickness, with respect to the middle and the sides, so the objects seen through it appear larger or more diminished; the effect should, therefore, be tried in heat.

A fifth to the second.

(5.) Let a careful experiment be made, to shew whether, by the most powerful and best-contrived burning-glass, the rays of the moon may be collected so as to afford any the most minute degree of warmth; but, if this warmth should prove too subtile and weak to be perceived by the touch, recourse must be had to thermometers, which shew the heat or coldness of air, so as to throw the moon's rays, by a proper burning-glass upon the top of such a thermometer, and observe whether the height of the included liquor be altered by the warmth.‖

* It is with certainty found by the barometer and otherwise, that the air grows rarer and rarer, in proportion to the height ascended upon hills.

† See Mr. Boyle's History of Cold, Abridgm. Vol. I. p. 574—584, &c.

‡ The meaning seems to be, instead of a lens, or double convex glass, to try a double concave.

‖ This experiment was tried by Dr. Hook, so far as to shew, that the rays of the moon are neither considerably hot nor cold; but the matter may require to be farther examined, by means of more accurate instruments. — See Hook's Lectures of Light, p. 80.

A sixth to the second.

(6.) Let a burning-glass be tried with a heat that is not luminous or shining, as that of iron or stone heated, but not ignited, boiling water, and the like, and observe whether the heat is increased, as in case of the sun's rays.

A seventh to the second.

(7.) Let a burning-glass also be tried with common flame.

An eighth to the third.

(8.) If we are disposed to reckon comets among the meteors, comets are not observed to have any constant or manifest effect in increasing the heat of the seasons, though droughts have been frequently observed to attend them. Bright gleams of light, star-shoots, the opening of the firmament, and the like, appear oftener in winter than in summer, and principally during intense cold, attended with dryness; yet lightning, corruscations, and thunder, seldom happen in the winter, but usually in sultry seasons; and those called falling stars are commonly thought rather to consist of some shining viscous matter, set on flame, than to be of any strong fiery nature. But this should be farther inquired into.*

A ninth to the fourth.

(9.) There are certain corruscations which afford light, but burn not, and these always happen without thunder.

A tenth to the fifth.

(10.) Eructations and eruptions of flame are no less found in cold countries than in hot ones, as in Iceland and Greenland; and trees in cold countries are sometimes more inflammable, pitchy, and resinous, than in hot ones, as the fir, the pine, &c. but in what situation and nature of soil these kind of eruptions usually happen has not hitherto been so well examined as to afford a negative to the affirmative.†

An eleventh to the sixth.

(11.) All flame is constantly hot, in a greater or less degree, so that there is here no negative at all subjoined; and yet they say that ignus fatuus has not much heat, being, perhaps, somewhat like the flame of spirit of wine, which is mild and gentle. But that flame seems still milder which some credible and grave historians relate to have appeared upon the heads of children, without burning or singing them, or only gently playing about their hair. And it is certain that there has sometimes been seen a corruscation, without manifest heat, about a horse, sweating in his journey by night, in clear weather:—and loaf-sugar and other things hard candied, being broke or scraped with a knife in the dark, yield light; so does sea-water, forcibly struck in rowing, and the froth of the sea strongly agitated in a storm by night.‡ But, as to

* Consider of the Aurora Borealis, and other appearances of light in the heavens.

† See the accounts of burning mountains, in the Philosophical Transactions, the Foreign Journals, Mr. Boyle's Works, &c.; and observe, that, in all natural inquiries, instances of various kinds, both on the negative and affirmative side, are frequently wanting, or have not been collected and recorded by authors; whence we see the necessity of a Sylva, or particular storehouse of observations and experiments, to be used as the materials in building a serviceable philosophy.

‡ Consider of the vitreous phosphori, or glass rubbed in the dark, the phosphorus of urine, and all the other kinds of phosphori, putrified flesh, putrified fish, diamonds, &c.—See Mr. Boyle upon Phosphori, and several pieces, to the same purpose, in the Philosophical Transactions, French Memoirs, &c.

the flame which the ancient mariners called Castor and Pollux, and the moderns term the Brothers, what kind of heat it has is not sufficiently known.

A twelfth to the seventh.

(12.) Every thing ignited to redness is perpetually hot, though without flame, and to this affirmative there is no negative subjoined; but what comes nearest to a negative seems to be rotten wood, which shines by night, without heat, and the scales of putrified fish, which also shine in the dark, yet are not hot to the touch; no more than the body of the glow-worm or lucciole, or light-fly.

A thirteenth to the eighth.

(13.) It is not sufficiently discovered, as to hot springs, in what situation and nature of the ground they usually flow; and, therefore, no negative is here subjoined.*

A fourteenth to the ninth.

(14.) A negative of the nature of fluidity is subjoined to heated fluids, from the thing itself, for there is no tangible fluid known, than in its own nature remains constantly hot;† but heat is superinduced upon it, for a time only, as an adventitious nature, so that the things most hot, potentially and operatively, as spirit of wine, distilled aromatic oil, oil of vitriol, &c. though they soon prove burning, are cold upon the first touch; and the water of hot springs being received into a vessel, and separated from its fountain, grows cold, like water heated by the fire. It is true, that unctuous bodies are somewhat less cold than water, silk than linen, &c. But this belongs to the tables of the degrees of cold.‡

A fifteenth to the tenth.

(15.) In like manner, a negation of the nature of vapour, such as we find it with us, is subjoined to hot vapours; for, exhalations from oily bodies, though easily inflammable, are not perceived hot, unless newly exhaled from the hot body.

A sixteenth to the tenth.

(16.) So likewise a negative of the nature of air is subjoined to hot air; for air is not found hot with us, unless it be shut up, rubbed, or worked together, or manifestly heated by the sun, fire, or other hot body.

A seventeenth to the eleventh.

(17.) Here we subjoin a negative, from the seasons colder than agrees with the time of the year, which seasons happen with us upon east and north winds, as the contrary do upon west and south winds.—So a tendency to rain, especially in winter, attends a warm season and a tendency to frost a cold one.

An eighteenth to the twelfth.

(18.) Here we subjoin a negative, from the air included in the same vaults or caves during the summer. But the business of included

* See Becher's Physica Subterranea and Hoffman's Pieces upon Mineral Waters.

† Therefore, fluidity is not of the nature of heat, or, in other words, fluidity is not essential to heat.

‡ See below, Aph. 13.

air should be very carefully examined; for, first, it may be well doubted, what is the nature of the air itself, as to heat and cold, since it manifestly receives heat from the impression of the celestial bodies, and cold, perhaps, from the expirations of the earth; and again, in that called the middle region of the air, from the cold vapours and snow; so that no true judgement can be made of the nature of the air, from the air abroad, and unconfined, but a better when it is shut up. And here it is necessary to include it in such a vessel or substance as may neither communicate heat nor cold, by its own nature, to the air, nor easily receive the impression of the external air; — let the experiment, therefore, be made in an earthen vessel, well covered with several leathers, to defend it from the external air, keeping the vessel well closed for three or four days, then opening it, to discover alteration, either by the hand, or a good thermometer, regularly applied.*

A nineteenth to the thirteenth.

(19.) There is likewise a doubt, whether the warmth in wool, furs, plumage, and the like, proceed from some small degree of heat inherent in them, as they grow, or are thrust out by the animals; or from a certain fat and unctuous substance, which is of a nature congruous to warmth; or whether, by shutting up and breaking off the communication of air, as in the foregoing article; for, all air, cut off from the continuity of the external air, seems to have something of warmth. Let the experiment, therefore, be tried in shaggy stuffs, made of linen, not of wool, feathers, or silk, which are animal excretions: it is likewise to be observed, that all powders, which manifestly include air, are less cold than the whole substance they were made from, and so we imagine that all froth, as containing air, is less cold than the liquor it is composed of.†

A twentieth to the fourteenth.

(20.) This has no negative subjoined, for there is nothing found among us, whether tangible or not tangible, which does not conceive heat, when exposed to the fire, though the bodies differ in this, that some conceive heat sooner, as oil, air, and water; and others slower, as stone and metal; but this belongs to the Table of Degrees.‡

A twenty-first to the fifteenth.

(21.) There is no other negative subjoined to this instance, but to have it well observed that no sparks are produced by a flint and steel, or any hard substance, without striking off some small parts from the substance of the stone or metal,‖ and that the attrition of the air does not produce the sparks as is commonly imagined; whilst the sparks, by the weight of the ignited body, rather tend downwards than upwards, and, upon going out, become a kind of fuliginous matter.

* See Mr. Boyle's History of Cold, in init.

† Here again, consult Mr. Boyle's History of Cold, though certain experiments seem still wanting, to give more full information in this case: but we are not here so far to regard the prosecution of the inquiry itself, as to forget that the thing proposed is to give an example of the method of conducting inquiries, though the author has all along contrived to carry on the inquiries themselves, at the same time that he gives examples.

‡ See below, Aph. 13.

‖ See Dr. Hook's Micrographia.

A twenty-second to the sixteenth.

(22.) We judge that no negative is producible to this instance, for we find no tangible body but what manifestly grows hot by attrition, whence the ancients imagined that the celestial bodies had no other means or faculty of growing hot, but by the attrition of the air, in their quick and rapid revolutions. But here it should be farther inquired, whether the bodies discharged out of engines, as bullets out of a gun, do not acquire some degree of heat from the percussion, so as to be found hot after their fall.* But air in motion cools more than it heats, as appears from winds, bellows, &c. for this motion is not so rapid as to excite heat, and is a motion of the whole, not of the particles, whence it is no wonder it should not generate heat.

A twenty-third to the seventeenth.

(23.) This instance should be diligently inquired into, for all herbs and green and moist vegetables seem to contain some secret heat, though so small as to be imperceptible to the touch in small portions; but, when many are joined and close shut up together, so that their spirit cannot breathe out into the air, but the parts must mutually foment and cherish each other, a manifest heat is produced, and sometimes a flame, if the matter be disposed thereto.†

A twenty-fourth to the eighteenth.

(24.) This instance also should be carefully examined, for quicklime seems to conceive heat when water is thrown upon it, either by the uniting of the heat, which was before scattered, as in the case of confined vegetables, just now mentioned, or because the fiery spirit is irritated or exasperated by the water, so as to make a conflict and struggle. This matter might be easily determined by using oil instead of water, because oil would serve as well as water to unite but not to irritate the included spirit. The experiment also should be extended as well to the ashes and the calxes of different bodies as to the use of different liquors.‡

A twenty-fifth to the nineteenth.

(25.) This instance has the negative of all other metals, which are more soft and yielding; thus gold, dissolved in aqua regia, lead in aqua fortis, and quicksilver in aqua regia, afford little heat to the touch, in the act of solution;‖ but silver and copper afford more, tin still more, and iron the most of all; and in the two latter, besides a strong heat, there is also excited a violent ebullition in the dissolution; whence the heat seems to proceed from the conflict, whilst the acid spirits enter, force into, separate, and divide, the parts of the resist-

* The heat of a leaden bullet, discharged barely by the force of the air, out of a wind-gun, against a metalline plate, so as to become considerably flatted, has been found so great as to burn the fingers, when taken up directly; — but it is not certain that bullets acquire heat barely by moving through the air. This might be commodiously tried with a wind-gun, and a proper instrument for discovering a small degree of heat.

† See above, Tab. I.

‡ See Mr. Boyle's Works, passim. and the Medicinal use of Lime-Water, in the French Memoirs, An. 1700.

‖ See the History of Condensation and Rarifaction.

ing body; but where the body yields easily, there is little heat produced.*

A twenty-sixth to the twentieth.

(26.) To the heat of animals we annex no negative, except that of insects, as was before observed,† on account of the smallness of their bodies; for, fish, compared with land-animals, have rather a degree of heat than a privation; but in vegetables and plants there is no degree of heat perceptible to the touch, neither in their tears nor in their medullary parts, newly laid open. In animals there is found a great diversity of heat, not only in their parts, (as the heat of the heart differs from that of the brain, and this again from that of the external parts,) but also with regard to accidents, as in violent exercises, fevers, &c.

A twenty-seventh to the twenty-first.

(27.) A negative can scarcely be subjoined to this instance, since even the stale excrements of animals have a manifest potential heat, as we see in the manuring of land.

A twenty-eighth to the twenty-second and twenty-third.

(28.) Such liquors, whether aqueous or oleaginous, as have a great and powerful acrimony, produce the effects of heat, in the separation and burning of bodies, after some time, though at first such liquors were not hot to the touch; and these liquors operate according to the pores of the body, whereto they are applied; for, aqua regia dissolves gold and not silver, aqua fortis dissolves silver and not gold, but neither of them dissolves glass; and so of liquors.‡

A twenty-ninth to the twenty-fourth.

(29.) Let trial be made of spirit of wine upon wood, butter, wax, or pitch, whether by its heat it will, in some degree, dissolve them; for, the twenty-fourth instance shews, that spirit of wine has a power resembling that of heat in scorching, and therefore let the experiment be made also in liquefaction. — Let trial likewise be made by a water-thermometer, with a hollow in the top, on the outside, and pour high rectified spirit of wine into that hollow, then cover it, the better to keep in the heat, and observe whether it makes the water fall or rise.‖

A thirtieth to the twenty-fifth.

(30.) Spices and plants that prove acrimonious to the palate are found much hotter when taken internally; let it therefore be considered in what other respects they may have the effect of heat. It is related by sailors, that, when large parcels of spices, which have been long kept close confined, come to be opened, those who first take them out, run the hazard of catching fevers and inflammations of the spirits. — Trial, therefore, might be made, whether the powders of such spices and herbs would not, like the smoke of fire, dry bacon or fish hung over them.

* The other solutions and mixtures, wherein heat is generated, might also be produced as instances to the present purpose. See the Chapter on Fire, in Boerhaave's Chemistry.

† See Table I.

‡ See the Chapter of Menstruums in Boerhaave's Chemistry.

‖ See the Chapter on Fire in Boerhaave's Chemistry.

A thirty-first to the twenty-sixth.

(31.) There is an acrimony or pungency both in cold things, such as vinegar and oil of vitriol, and in those potentially hot, such as oil of origanum, &c. whence they both alike cause pain in animate bodies, and separate and consume the parts in such as are inanimate. Nor is any negative annexed to this instance; but there is no pain in animals without a certain sensation of heat.

A thirty-second to the twenty-seventh.

(32.) There are many actions in common to heat and cold, though they differ greatly in the manner; thus snow seems to burn soon after it is handled; cold preserves flesh from putrifaction as well as the fire, and heat makes some bodies shrink as well as cold, but it is more proper to refer these and the like instances to the inquiry about colds.*

13. In the third place, those instances must be brought before the understanding, in which the nature inquired after resides, according to the degree of more or less, whether the comparison of increase or decrease be made in the same subject, or respectively in different subjects; for, as the form of a thing is the very thing itself, or as a thing differs not from the form, otherwise than appearance does from existence, external from internal, or with respect to man and with respect to the universe;† it follows, that no nature should be received as a true form, unless it perpetually decrease when the nature decreases, and perpetually increase when the nature increases. The Table representing this, we therefore call the Table of Degrees, or the Table of Comparison.

We shall first, therefore, consider such things as to the touch shew no degrees of heat at all, but seem only to have a certain potential heat, or a disposition and preparation towards actual heat, and next proceed to such as are actually hot, or hot to the touch, and observe their different strengths or degrees.

TABLE III.

A Table of the Degrees of Heat.

(1.) Among all the solid and tangible bodies, there is nothing found originally hot in its own nature; no stone, metal, sulphur, or other fossil; no wood, water, or animal carcase; for the water of hot wells seems to be heated accidentally, either by flame or subterraneous fire, such as is thrown up by Ætna and many other burning mountains; or else by the conflict of bodies, as heat is produced in the dissolutions of iron or tin;‡ therefore, to the human touch there is no degree of heat in inanimate bodies; and those we have mentioned also differ in degree of heat, for wood is not so cold as iron.—But this belongs to the Table of Degrees for the History of Cold.

(2.) But for potential heats and dispositions to flame, there are numerous inanimate bodies found greatly disposed thereto, such as sulphur, naphtha, and petreol.

* See Mr. Boyle's History of Cold.

† These expressions may give us a fuller information as to what the Author means by forms.

‡ See Table II.—Consider also of the spontaneous heating of Marcasites with water, iron filings and sulphur moistened with water, and other instances of this nature.

(3.) The bodies that are previously heated, as horse-dung in the animal, quick-lime, and perhaps ashes or soot by the fire, retain some secret remains of their former heat, whence certain digestions, distillations, and separations, are made of bodies by burying them in horse-dung; and thus heat is excited in quick-lime, by throwing water upon it, as was before observed.*

(4.) Among vegetables there is no plant, or part of a plant, whether the excreted tear or internal pitch, found hot to the human touch; but green plants, as above instanced, become hot by pressure, and some vegetables are found hot, others cold, to the internal touch, viz. to the palate or stomach, or even to the external parts, after continuing applied for some time, as we see in plasters and unguents.†

(5.) There is nothing found hot to the human touch in the parts of animals after death, or after separation from the body. Even horse-dung retains not its heat, unless it be pressed together and buried; yet all dung seems to have a potential heat, as appears from composts and manuring. In like manner, the carcasses of animals have a latent and potential heat, insomuch that, in the church-yards where burials are frequent, the earth collects a certain heat, which consumes a carcass newly laid in it much sooner than mere earth.‡ And it is reported that the people of the east have a certain fine soft cloth, made of birds' feathers, which, by its native heat, will dissolve butter gently wrapt up therein.‖

(6.) Those things that mend land, such as dungs of all sorts,§ chalk, sea-sand, salt, &c. have some disposition to heat.**

(7.) All putrifaction is attended with some small tendency to heat, though not so much as to be perceived by the touch;†† for neither those things, which, when putrified, turn to animals, as flesh, cheese, &c. are found hot to the touch, nor rotten wood that shines in the dark; but heat sometimes discovers itself in putrifactions by highly fœtid and abominable odours.‡‡

(8.) The first degree of heat, therefore, of those things which feel hot to the human touch, seems to be that of animals, which has no very great extent in its degrees; for the lowest, as in insects, is scarcely perceptible to the touch, and the highest scarcely equals the heat of the sun in hot countries and seasons, nor is it so great but the hand may endure it; though it is related of Constantius and some others of a very

* Table I. and Table II.

† Thus the *Emp. Epispastic. Emp. Stomachic. magistral. Emp. e Cymino. Ung. Martiat. Ung. Mastichin*, &c. are heating; and *Emp. de Ranis cum Mercurio, Emp. e Cicuta, Ung. Nutritum, Ung. Populneum*, &c. are cooling.

‡ Is the fact sufficiently verified?

‖ This may require farther confirmation.

§ Except that of geese, according to vulgar observation.

** But is this disposition greater that that of many things which do not mend land? And, in this light, what is to be said of nitre?

†† Nor, as is said by a thermometer, applied to a putrifying animal carcass, though this may require to be more exactly tried.

‡‡ The argument seems conclusive; for odours, perhaps, cannot exist without a certain degree of heat.—See Boerhaave's Chemistry, under the Chapter of Fire and the Process of Putrifaction. See also Mr. Boyle's Works, passim.

dry habit of body, that they have been so hot in acute fevers as in a manner to burn the hand applied to them.*

(9.) Animals have their heat increased by motion, exercise, wine, high feeding, venery, burning fevers, and by pain.

(10.) Men in the fits of an intermitting fever are first seized with cold and shivering, and soon after grow very hot, but they continue hot from the beginning in burning and pestilential fevers.

(11.) Let farther inquiry be made of the comparative heat in different animals, as fish, quadrupeds, serpents, and birds; and again, in their different species, as in man, the lion, the kite, &c. for, according to common opinion, fish have little heat in their inward parts, but birds a great deal, especially pigeons, hawks, and ostriches.

(12.) Farther inquiry should likewise be made of the comparative heat of the same animal, in its different parts and limbs, for milk, blood, sperm, and eggs, are found moderately tepid, or less hot than the outward flesh of the creature, upon exercise, or when moved or excited, but it has not hitherto been examined what the degree of heat is in the brain, stomach, heart, &c.

(13.) All animals are externally cold in the winter and cold seasons, but are then thought to be hotter within.†

(14.) The heat of the celestial bodies, even in the hottest countries and hottest times of the year and day, is not able to fire the driest wood, straw, or tinder, unless strengthened by the burning-glass, though it may raise a vapour from moist matters.‡

(15.) According to the tradition of astronomers, some stars are more and others less hot, Among the planets, Mars is said to be the hottest, or next to the sun; then Jupiter, and then Venus; but the Moon is supposed to be cold, and Saturn the coldest planet of all. Among the fixed stars, Sirius is supposed the hottest, then Cor Leonis, then the smaller Dog-star, &c.

(16.) The sun proves hotter to us the nearer he comes to the perpendicular, or zenith, and the same is to be understood of the planets, according to their different degrees of heat; for example, Jupiter proves much hotter to us when he is in Cancer, or Leo, than when in Capricorn or Aquarius.

(17.) It is to be supposed that the sun and all the planets heat more in their perigee, when they are nearest the earth, than in their apogee, when they are farthest from it; but, wherever the sun is at the same time both in its perigee and nearest the zenith, it must necessarily be hotter, than where the sun is in its perigee, but farthest from the zenith: so that the comparative ascensions of the planets must be here regarded as they approach to or recede from the perpendicular in different countries.

(18.) The sun and planets are supposed hotter in their appulse to the larger fixed stars;—so, when the sun is in Leo, it is nearer the Cor

* This seems to be no unfrequent case, when inflammatory fevers happen in robust and sanguine constitutions, if by burning the hand be meant a disagreeable or somewhat painful sensation of heat.

† Suppose, by what is called Antiperistasis, but this does not, perhaps, appear by the thermometer. — See Mr. Boyle's History of Cold, and Dr. Boerhaave's Chemistry, under the Chapter of Fire.

‡ The direct rays of the sun are said to be capable of melting lead in certain climates, or even to fire the houses.—See Boyle, Abridgm. Vol. III. p. 55, &c.

Leonis, the Cauda Leonis, Spica Virginis, Sirius, and Canicula, that when in Cancer, where yet it is nearer the zenith. And it is to be supposed that those parts of the heavens give the greatest heat, though not perceptible to the touch, that are fullest of stars, especially stars of the first magnitude.

(19.) The heat of the celestial bodies is increased three ways, viz. (1.) by their perpendicularity, (2.) their nearness of approach, or perigee, and (3.) by the stars lying thick together.

(20.) There is a very great difference found between the degree of heat in animals and that of the celestial bodies, as it affects us on the one side, and the mildest flame, all ignited bodies, or even liquors, and the air itself, much heated by the fire, on the other; for, the flame of spirit of wine, even though diffused and uncollected, is able to burn straw, linen, or paper, which animal heat will not do, nor solar heat, without the assistance of the burning-glass.

(21.) But there are numerous degrees of strength and weakness of heat in flame and bodies ignited, though, as no careful inquiry has been made about them, we are obliged to pass them lightly over.—(1.) The flame of spirit of wine seems to be the softest, unless we except the ignus fatuii and the corruscations of sweating animals. (2.) The flame of spirit of wine, we judge, is succeeded by the flame of porous and spongy vegetable, as straw, rushes, and dried leaves, from which the flame of hair or feathers does not greatly differ. (3.) Next to this, perhaps, may follow the flame of wood, especially such as abounds not in rosin or pitch, but the flame of brush-wood or twigs, which are commonly bound up into faggots, is more gentle than that yielded by the trunks and roots of trees, as is found by experience in the furnace for melting iron from the stone, where small wood is of little service.—(4.) Next to this comes, in our estimation, the flame of oil, tallow, wax, and the like unctuous and fat bodies, which have no great acrimony.—(5.) But a stronger heat is found in pitch and rosin.—And (6.) a still stronger in sulphur, camphire, naphtha, petreol, and salts, after their crude matter is discharged; and, in the composition hereof, as in gunpowder and wild-fire of different kinds, which have so stubborn a heat that water can hardly extinguish it.

(22.) (7.) We suppose, also, that the flame arising from certain kinds of imperfect metals is exceedingly strong and sharp,* but of this a farther inquiry should be made.

(23.) (8.) The flame of strong lightning seems to exceed all the former, so as sometimes to melt perfect iron itself into drops, which those other flames cannot do.

(24.) (9.) There are also different degrees of heat in bodies ignited, though these likewise have not hitherto been diligently inquired into. The weakest heat of this kind we take to be, (1.) that of tinder, and the match used in the firing of great guns; after which come (2.) ignited charcoal, pit-coal, brick, &c.; but (3.) the hottest of all ignited bodies seem to be metals, as copper, iron, &c. though farther inquiry should be made about them.

(25.) Some ignited bodies are found much hotter than some flames, for ignited iron is much more hot and burning than the flame of spirit of wine.

* As in making the common regulus of antimony, prince's metal, with zinc and copper, and many other metallurgical experiments.

(26.) There are also some bodies, which, though unignited, and only heated by the fire, such as boiling water and air pent up in reverberatory furnaces, are hotter than many flames and bodies ignited.

(27.) Motion increases heat, as appears by bellows and blow-pipes, insomuch that the harder metals will not melt in a dead or still fire that is not animated by the blast.

(28.) Let trial be made with the burning-glass; for, as I remember, if the glass be held, for example, at the distance of ten inches from a combustible body, it will not then burn so much as if it be first placed at the distance of five inches, and then be gradually and slowly drawn away to the distance of ten, though the collection and cone of rays remain the same, the bare motion thus increasing the effect of the heat.

(29.) Those conflagrations which happen in the time of a strong wind are thought to advance faster towards the wind than from it, because the flame recoils swifter when the wind slackens than it advances forward when the wind drives it.

(30.) Flame proves strong, vigorous, and generative, only when it finds some cavity wherein to move, and play, and exert itself; except the flatulent flame of gunpowder and the like, where compression and confinement increase its force.

(31.) The anvil grows very hot by the repeated strokes of the hammer, so that, if it were thin, we judge it might be ignited by strong and successive strokes, but this remains to be tried.*

(32.) But in such ignited bodies as are porous and afford space enough for the fire to move in, if the fire's motion be not curbed by a strong compression, the fire is extinguished; as when tinder, or the burning wick of a lamp, a flaming coal, &c. is squeezed by the foot, or the like, upon which the effects of the fire presently cease.

(33.) The approach of a hot body increases heat according to the degree of nearness, and the case is the same in light, for the nearer an object is placed to the light the more visible it becomes.

(34.) The uniting of different heats increase heat, unless the bodies come to be mixed; for, a great fire and a small one being near each other, somewhat increase each other's heat; but warm water put into boiling water, cools it.

(35.) The continuance of heat in a body increases heat, for heat thus perpetually flying off is mixed with the heat before existing, so as to multiply the heat. Thus a fire kept up for half an hour, does not heat the room so much as if the fire were kept up for an hour; but this is not the case in light, for a lamp does not enlighten a room more by long continuing to burn than when it is first lighted.

(36.) External cold increases heat; for we find that fire scorches violently in frosty weather. This, we conceive, happens not only from the heat being shut up and contracted, which is a kind of union,† but also by irritation. Thus, when the air, or any elastic body, is violently compressed or bent, it recoils not only to the point it was forced from, but beyond it. Therefore let careful trial be made, by placing some

* It is certain that a piece of iron has, by various strokes of the hammer, nimbly repeated, been soon made to appear red hot, insomuch that this is sometimes accounted no bad expedient for lighting a fire among sailors, and those workers in iron who use a quick hammer.—See Dr. Hook's Lectures of Light, p. 117.

† See Sect. (34.)

combustible material in flame, to shew whether it will not be burnt sooner on the surface than in the midst of the flame.*

(37.) There are many degrees in the reception of heat; and, first, it is to be observed, how small and slender a heat may somewhat change and a little warm those bodies which are least of all susceptible of heat; for the heat of the hand will warm a bullet of lead or any other metal, held for a while in it; so easily and in all cases is heat transmitted and excited, though the body to appearance seems no way changed.

(38.) But of all bodies that we know, air the easiest receives and communicates heat, as appears by weather-glasses, which are made thus: — Take a bellied glass, with a long and slender stem, and invert the nib of it into another glass vessel of water, so that the aperture of the first glass may touch the bottom of the second, whilst the stem is supported a little by the mouth of the under glass, so as to stand, without having its orifice entirely closed; and, the better to effect this, apply some wax to the mouth of the under receiving glass, but so as not to stop this up neither. Before the bellied glass is inverted into the other, let its belly be heated at the fire; and, when placed as above-mentioned, the air, which was dilated by the heating, will contract itself (after the adventitious heat is gone) to an equal dimension with that of the external or common air at the time, and raise the water upwards in the same proportion; and now, when a scale of degrees, made upon a long slip of paper, is pasted along the stem, according as the weather grows hotter or colder, the included air will contract with the cold and expand with the heat, and shew the effect by the ascent of the water when the air is contracted, and by the descent thereof when the air is expanded.— But the sensibility of the air, in respect of heat and cold, is so subtile and exquisite, as far to exceed the perception of the human touch; insomuch that a ray of the sun, or the warmth of a man's breath, much more the heat of one's hand, placed upon the top of the glass, will immediately cause the water manifestly to sink.† Though we conceive that the spirit of animals has a still more exquisite sense of heat and cold, unless it be obstructed and blunted by the grosser matter of their bodies.

(39.) Next to air, we judge those bodies to be most sensible of heat which are newly changed and compressed by cold, such as, 1, snow and ice, for these begin to relent and dissolve with any gentle heat; 2, after these, perhaps, comes quicksilver; after this comes, 3, fat bodies, such as oil, butter, &c; 4, wood; 5, water; 6, and lastly, stones and metals which do not easily heat, especially within, though they very long retain the heat they have once received; so that a red-hot brick, stone, or piece of iron, quenched in a basin of cold water, retain such a heat for some minutes after that they cannot be handled.

(40.) The less bulk a body is of, the sooner it conceives heat, by the approach of a hot substance, which shews that all heat with us is in a manner averse to tangible bodies.‡

(41.) Heat, to the sense and human touch, is an undetermined rela-

* See Dr. Hook's Lectures of Light and Discourse of Comets. See hereafter, also, Aph. 20.

† For the improvement of thermometers, see Mr. Boyle's History of Cold, and Dr. Hook's Works, passim. See also Dr. Boerhaave's Chemistry.

‡ As being readiest communicated in the smallest and perhaps the most rarified bodies.

tive thing, so that warm water shall seem hot to a cold hand, and cold if the hand be hot.*

14. How unprovided we at present are in natural and experimental history may be easily observed from this, that, in the preceding tables, we are frequently obliged to direct experiments and farther inquiry to be made into particulars, and that, instead of approved history, and such instances as may be depended upon, we are sometimes driven to insert traditions and relations, though we do this always with a manifest doubting of their truth and authority.†

15. The office and use of these three tables is to present a view of instances to the understanding; and, when this view is procured, the business of induction is to be put in practice; for, upon a particular and general view of all the instances, such a nature is to be discovered as may be continually present or absent, and always increase and decrease with that nature; and, as we before laid down, limit the more common nature.‡ But, if the mind should attempt to do this affirmatively from the first, as it uses to do when left to itself, there presently rise up phantoms and notional hypotheses, ill defined, and axioms that daily require a mending hand, unless, after the custom of the schools, we would contend for falsehood, though doubtless these axioms would be better or worse, according to the powers and strength of the understanding that formed them. God, the great Giver and Creator of Forms, doubtless knows them by immediate affirmation, at the first glance of the understanding; and so, perhaps, may angels, and such sublime intelligences, but this far exceeds the human capacity, which can only first proceed by negatives; and lastly, after a perfect exclusion, end in affirmatives.

16. We must, therefore, make a perfect resolution and separation of nature, not by fire, but by the mind, which is, as it were, the divine fire; and thus the first work of genuine induction in the discovery of forms is to throw out or exclude such particular natures as are not found in any instance where the given nature is present, or such as are found in any instance where that nature is absent; and again, such as are found to increase in any instance when the given nature decreases, or to decrease when that nature increases; and then, after this rejection and exclusion is duly made, the affirmative, solid, true, and well-defined form, will remain as the result of the operation, whilst the volatile opinions go off in fume;|| and this is easily expressed in words, but the thing itself cannot be come at without numerous turnings and windings. We will, however, endeavour not to omit any one step that conduces to the end.

* See Mr. Boyle's History of Cold, in init.

† Little progress can be expected in philosophy and the sciences till an ample and exact History of Nature and Art is procured, out of which, as out of a storehouse, particulars should be drawn, as they come to be wanted, in all inquires.

‡ See Part II. Aph. 4.

|| The metaphor seems taken from the operation of testing, or the way of refining or assaying gold and silver ore with lead, which very appositely illustrates this method of induction; the lead, some way or other, carrying off with it whatever is volatile or vitrifiable, and not true gold or silver. For thus the proper set of instances being procured, (like an ore wherein the nobler metals are contained,) they are tried by induction, as in the furnace, so as to leave the true form behind, like a brill of gold or silver, upon the test.

17. But here a general caution or perpetual admonition must be given, lest, as we seem to attribute so much to forms, what we say of them should be understood of such forms as men have hitherto accustomed themselves to consider.*

For, (1.) we do not at present speak of compound forms, that is, combinations of simple natures, according to the common course of the universe; as the form of an eagle, a lion, a rose, gold, &c.; the time of treating which will be when we come to concealed processes and secret textures, and the discovery of them, as they are found in those called substances, or concrete natures.†

(2.) And even in the case of simple natures, we must not be understood to mean any abstract forms or ideas, that are either undetermined or ill determined in matter. For, when we speak of forms, we mean no other than those laws and determinations of pure action, which regulate and constitute any simple nature, as heat, light, and gravity, in all kinds of matter susceptible thereof; and therefore the form of heat, or the form of light, is the same thing as the law of heat, or the law of light, for we perpetually keep close to practice, and things themselves;‡ and, therefore, when we say, for example, in the inquiry into the form of heat, reject tenuity,‖ or tenuity is not of the form of heat, it is the same as if we said, men may superinduce heat, upon a dense body; or, on the other hand, that men may take away heat from a rare one.§

(3.) And if any one shall think that our forms have somewhat abstracted in them, because they appear to mix and join together things that are heterogeneous, as the heat of the celestial bodies, and the heat of fire; the fixed redness of a rose, and the apparent redness of the rainbow, the opal, or the diamond; death by drowning, and death by burning, stabbing, the apoplexy, consumption, &c. which, though very dissimilar, we make to agree in the nature of heat, redness, death, &c.; he must remember, that his own understanding is held and detained by custom, things in the gross, and opinions. For it is certain, that the things above-mentioned, however heterogeneous and foreign they may seem, agree in the form, or law, that ordains heat, redness, and death. Nor can the human power be otherwise freed, and set at liberty from the common course of nature, and extended and exalted to new efficients, and new ways of working, than by disclosing and investigating this kind of forms. But after treating of this unity of nature,** which is a most capital thing, we shall proceed to the true divisions and paths of nature, as well the ordinary as internal.††

18. But we are next to propose an example of the exclusion or rejec-

* Viz. The peripatetic, or notional forms, &c.

† See *De Augment. Scientiar.*

‡ Certainly this caution has not been sufficiently observed, whence many have conceived this Second Part of the Novum Organum to be rather a deep, or, according to the vulgar expression, a metaphisical speculation, than a thing directly tending to operation; or, what it is in reality, with regard to the mind, practice itself.

‖ See below, *Table* IV.

§ It cannot be too well remembered, nor perhaps sufficiently inculcated, that theory and practice, in the mind, are but one and the same thing; or differ no more, in any respect, than as cause and effect, or rule and work.

** See *Part* II. *Aph.* 3.

†† See below, *Sect.* II. *passim.*

tion of those natures, which, by the tables of view, are found not to be of the form of heat; admonishing, by the way, that not only each table suffices for the rejection of any nature, but also every single instance contained in each table; for it is manifest, from what goes before,* that any one contradictory instance destroys the notion of form. However, for clearness sake, we sometimes double or repeat the exclusion, the better to demonstrate the use of the tables.

TABLE IV.

An Example of the Exclusion or Rejection of Natures, from the Form of Heat.

(1.) By the sun's rays, reject elementary or terrestrial nature from the form of heat.†

(2.) By common fire, and principally by the subterraneal fires, which are very remote, and entirely cut off from the celestial rays, reject celestial nature.

(3.) By the heating of all kinds of bodies, whether mineral, vegetable, or animal; whether water, oil, air, &c.; upon the bare approach of fire, or other hot body, reject all variety, or subtile texture of bodies.

(4.) By iron, and ignited metals, which heat other bodies, without loss of weight or substance, reject communication, or mixture of any other hot substance.

(5.) By hot water, hot air, metals, and other solid bodies that will receive heat without ignition, reject light and splendor.

(6.) By the rays of the moon and stars, except the sun, again reject light and splendor.

(7.) By the comparison of ignited iron, and the flame of spirit of wine, whence the iron appears to be hotter and less lucid, but the flame of the spirit more lucid and less hot, again reject light and splendor.

(8.) By Gold and other ignited metals, which are very dense in their entire substance, reject tenuity.

(9.) By air, which is generally found cold, and yet remains thin and subtile, again reject tenuity.

(10.) By ignited iron which swells not in bulk, but remains of the same dimensions to appearance,‡ reject local or expansive motion in the whole.

(11.) By the dilatation of the air in weather-glasses, and the like, where the air is evidently moved locally and expansively, without becoming manifestly hotter, again reject local or expansive motion in the whole.

(12.) By the facility wherewith all bodies are warmed, without destruction, or remarkable alteration, reject destruction, and great communication of any new nature.

* See in particular, *Aph.* 4, 16, &c.

† That is, since the sun's rays are found to be hot, a terrestrial or elementary nature is not of the form of heat, or heat is not confined to terrestrial or elementary bodies. See below, *Aph.* 19 and 20. (31.)

‡ Though not upon exact trials. Let it be considered how justly this expansion, or rarifaction of the whole body, has been made by some the universal criterion, or form of heat. See below, *Aph.* 20. (8.) (15.) (13.) (26.)

(13.) By the similitude and conformity of certain operations, performed both by cold and heat, reject as well expansive as contractive motion in the whole.

(14.) By fire following heat upon the attrition of bodies, reject principle nature; that is, a positive nature, not caused by a precedent one.

N. B. There are also other natures to be excluded, for our tables are not designed as perfect, but only as examples.

N. B. Neither all, nor any one of the preceding natures, are of the form of heat; so that men, in their practices upon heat, are freed from the necessity of introducing any or all of them.*

19. The business of exclusion lays the foundations for a genuine induction, which, however, is not perfected till it terminates in the affirmative: but our exclusion is by no means perfect, nor can it possibly be so at first. For exclusion, as we plainly see, is the rejection of simple natures; and, if we have hitherto no just and true notion of simple natures, how can the business of exclusion be rectified? But some of the above-mentioned notions, as those of elementary nature, celestial nature, and tenuity,† are vague and ill defined. Wherefore, not forgetting how great a task we have undertaken, viz. no less than that of rendering the human understanding equal to things and nature, we are by no means to stop here, but must proceed to invent and afford greater helps to the mind. For, doubtless, in the interpretation of nature, the mind is to be so prepared and formed, that it may both rest upon proper degrees of certainty, and yet conceive, especially in the beginning, that the things which are present have a great dependance upon those behind.‡

20. And yet, because truth will sooner emerge from error than from confession, we judge it useful to allow the understanding, after having made and considered the three tables of preparatory view, in the manner we have laid them down, to apply itself, and attempt the business of interpreting nature in the affirmative, on the strength of the instances contained in these tables, and such as may be otherwise procured.—And this kind of attempt we call a permission to the understanding, the rudiments of interpretation, or the first vintage of inquiry.||

TABLE V.

The first Vintage, or Dawn of Doctrine, from the Form of Heat.

(1.) It appears, from the preceding doctrine, that the form of a thing resides in all the particular instances wherein the thing resides, other-

* Observe how this investigation of forms corresponds to a just practical rule, (for producing unlimited effects,) laid down above, under *Aph.* 4. (5. and 6.) If due attention has been used, the reader will now begin to see the scene open, and find cause to expect more considerable things from the human power and knowledge than have hitherto been produced by any philosophers unacquainted with the true method of inquiry into nature, by the means of this new engine of the mind.

† See *Table* IV.

‡ See *Part* I. *Aph.* 130, *ad finem.*

|| The first vintage, in wine countries, produces the poorest wines, which they usually distil for brandy, as being not fit to keep in the form of wines.

wise it would not be a form ;* and therefore no contradictory instance hereof can be given.

(2.) Yet the form is found much more conspicuous in some instances than in others, especially in those where the nature of the form is less confined, obstructed, and subdued, by other natures ; and this kind of instances we call shining or glaring instances.† And thus we now proceed to reap the first fruits of our inquiry after the form of heat, in the way of example.

(3.) In all instances, considered as well separately as collectively, the nature whose limitation is heat appears to be motion.‡ This we find chiefly in flame, which is in perpetual motion; and in hot or boiling liquors, which are also in a continual agitation. It likewise appears, by the sharpness or increase of the heat, caused by motion, as in bellows and blasts ;‖ and again, in other kinds of motion, for which see the twenty-eighth and thirty-first instances of the third table. It is found also in the extinguishing of fire and heat, by all strong compression, which checks and puts a stop to motion. See the thirtieth and thirty-second instances of the third table. Again, it is shewn by this, that all bodies are destroyed, or at least remarkably altered, by all kinds of fire, or strong or vehement heat ; and hence it plainly appears, that heat causes a tumult, disturbance, and brisk or eager motion in the internal parts of bodies, which gradually tends to a dissolution of the body.

(4.) What we have thus said of motion is to be understood of it as of a genus,§ with regard to heat, and not as if heat generated motion, or as if motion generated heat, though this may be true in some cases ; but the meaning is, that heat itself, or the very existence of heat, is motion, and nothing else ;** though motion, limited by the differences we shall presently subjoin, after giving a few cautions for the avoiding of ambiguity.

(5.) Heat to the sense is a relative thing, that regards mankind, not the universe, and is justly assigned only as the effect of heat upon the animal spirit or mind, being in itself an indeterminate thing, for the same body, according as the sense is predisposed, may give the perception as well of heat as of cold, as appears by the forty-first instance of the third table.

(6.) But the communication, or transitive nature of heat, whereby one body conceives heat upon being applied to another that is hot, must not be confounded with the form of heat, for heat is one thing and heating another. Heat is produced by the motion of attrition, without any heat preceding that motion, whence heating is excluded from the form of heat. And when heat is produced by the approach of a hot body, this does not proceed from the form of heat, but depends entirely upon a higher and more common nature,†† viz. upon the nature

* See *Part* II. *Aph.* 4.
† See below, *Sect.* II. *Aph.* 24.
‡ See *Aph.* 4.
‖ See Tab. III. Instance 27.
§ Or universal kind.
** See *Part.* II. *Aph* 4.

†† This is a subtile and curious distinction. The meaning appears to be, that, when heat is once produced by the existence of its form, that is, by a particular motion, it propagates itself, not by means of its form, but by the principle of assimilation, or self-multiplication.—See Sir Isaac Newton upon the Heat of Comets. Princip. Lib. III. p. 467, &c.

of communication, assimilation, or self-multiplication, which demands a separate inquiry.

(7.) The notion of fire is vulgar, and composed of heat and splendor as existing in some one thing, for example, in common flame and bodies ignited, or made red-hot; and, having thus removed all ambiguities, we at length come to the true differences, which limitate motion, so as to constitute it the form of heat.*

I.

(8.) The first difference is this, that heat is an expansive motion, whereby a body endeavours to dilate itself, and stretch into a greater sphere or dimension than it before possessed;† and this difference appears principally in flame, where the smoke, or unctuous matter, manifestly dilates and opens itself into flame. It appears likewise in all boiling liquors, which manifestly swell, bubble, rise up, and carry on their process of expansion, till they change into a much more rarified body than the liquors themselves, as for example, into vapour, flame, or air.

(9.) It appears likewise in wood and all combustible bodies, which sometimes sweat but always evaporate.

(10.) It appears again in the melting of metals, which, being of a very compact substance, do not easily swell and dilate, yet their spirit,‡ after being itself dilated, and endeavouring at a still greater extension, forces and agitates the more gross parts into a more fluid state; and, if the heat be greatly increased, it resolves, volatizes, and drives off, much of their substance.

(11.) It appears also in iron and stone, which at least are softened, if not liquified and fused, by fire. So likewise rods of wood become flexible by being somewhat heated in hot ashes.

(12.) But this motion is best perceived in air, which continually and manifestly dilates itself with a small heat, according to the thirty-eighth instance of the third table.‖

(13.) Again, it appears from the contrary nature of cold, for cold contracts all bodies and makes them shrink, insomuch that nails have dropped out of walls, and brass vessels have cracked, through cold; so likewise glass heated, and suddenly brought into the cold, cracks and flies to pieces. Air contracts itself even upon lightly cooling, as appears by the thirty-eighth instance of the third table:§ but the full consideration of these particulars belongs to the inquiry of cold.

* See Part II. Aph. 4.

† Observe, that this does not contradict but coincide with the tenth and eleventh instances of the fourth table, though the correspondence may not, perhaps, appear at first sight.

‡ See the *Sylva Sylvarum*.

‖ Neither does this contradict the eleventh instance of the fourth table. The assigning of these differences is a particular work of the understanding, employed solely in adjusting and reconciling the instances of the preceding tables, without distraction or avocation.

§ It should here be remembered, that water expands in freezing, for ice is specifically heavier than the water that affords it. How this happens, the Author explains in the History of Condensation and Rarifaction. But, perhaps, if the water be very well purged of its air before it is frozen, the ice will not be lighter than water.—See Boerhaave's Chemistry, under the Chapters on Fire and Water. See also Mr. Hawksbee's Physico Mechanical Experiments, p. 257.

(14.) And it is no wonder that cold and heat should perform many actions in common, according to the thirty-second instance of the second table, because two of the differences, which we shall presently mention, belong to both natures, though, in the present difference, their actions are diametrically opposite, for heat gives an expansive and cold a contractive motion.

II.

(15.) The second difference is a modification of the former, and depends upon this, that heat is an expansive motion, or a motion towards the circumference, but with this law, at the same time, that it rises upwards. And we cannot doubt but there are many mixed motions, as that of an arrow, for example, which revolves in going forwards, and advances by revolving; and, in like manner, the motion of heat is, at the same time, both expansive and upwards.

(16.) This difference is perceived by heating one end of an iron rod, held perpendicularly in the fire, in which posture it will burn the hand much sooner at the other end than if it were held aslope or downwards.

(17.) This difference also appears from distillation *per descensum*, or the method of distilling downwards, (which is practised upon curious flowers, whose odour is easily lost,) viz. by applying the fire, not below but above the subject, that it may scorch the less, for not only flames but all heat tends upwards.

(18.) Let trial be made of this in the contrary nature, that of cold, to find whether cold will not contract bodies by moving downs, as heat dilates them, by rising upwards. Take, therefore, two iron rods, or two glass tubes, exactly alike, heat them a little, and place a spunge full of water, or a quantity of snow, under the one, and in like manner over the other, for we conceive that rod or tube will cool faster at the farther end where the snow lies at the top than where it lies at the bottom, contrary to what happens in heat.*

III.

(19.) A third difference is this, that heat is not an expansive uniform motion in respect of the whole,† but expansive in the smaller particles of a body, and at the same time checked, repelled, and reverberated, so as to become an alternative, perpetually shuddering or struggling, motion or action, which is irritated by the re-action of the body,‡ whence proceeds the violence of fire and heat.

(20.) And this difference appears chiefly in flame and boiling liquors, which continually tremble, swell in their small particles and again subside.

(21.) It appears also in such bodies as are of too hard a texture to swell, or increase remarkably in bulk, when heated or ignited, as red-hot iron, in which the heat is very intense.‖

* See the experiments of the Academie del Cimento at the end, and Mr. Boyle's History of Cold.

† As when a bladder is distended by blowing into it.

‡ As when a nail is driven up to the head in a board, and made to shudder and vibrate in its small parts by the stroke of the hammer.

‖ It should seem as if this shuddering action were visible in iron, even though heated below the degree of ignition; for, in looking upon such heated iron, the eye receives an odd impression of a particular kind of waving or recurrent motion.

(22.) It also appears from this, that fire burns sharpest in the coldest weather.

(23.) Again, it appears from this, that, when the air stretches uniformly and equably in a weather-glass, there is no sensible heat perceived: and even confined winds, though they blow and move violently, yet produce no remarkable heat, because the motion is the motion of the whole, without an alternative or shuddering motion in the particles; and to this purpose let trial be made whether flame does not burn sharper on the surface than in the middle.*

(24.) Lastly, it appears from this, that all burning passes through the minute pores of the body burnt, so that the burning undermines, saps, penetrates, and enters, like the points of an infinite number of needles; and hence it is that all acid spirits, if suited to the body they act upon, have the effect of fire, from their dissolving or corroding nature.†

(25.) And this difference we now speak of is common to the nature of cold, wherein the contractive motion is restrained by the contrary endeavour of expansion, as the expansive motion is checked in heat by the opposite endeavour of contraction: and, therefore, whether the parts of a body penetrate from without inwards, or from within outwards, the case is similar, though the force be very unequal, because we have no body here upon the surface of the earth, that is intensely cold.‡

IV.

(26.) The fourth difference is a modification of the last, and depends upon this, that the preceding motion of stimulation or penetration be somewhat rapid, or no way sluggish, and also play among such particles as, though minute, yet are not extremely fine, but, as it were, of a moderate size.‖

(27.) This difference appears upon comparing the effects of fire and the effects of time or age, which withers, consumes, undermines, and reduces, bodies to ashes, as well as fire, or rather much more subtily; but because this kind of motion is exceedingly slow, and exercised upon very fine particles, the heat is not perceived.

(28.) It again appears, upon comparing the dissolutions of iron and gold, for gold dissolves without causing a manifest heat, but iron excites a strong one, though scarcely dissolves quicker than gold, because in gold the menstruum not only enters milder and more subtily, but the parts of the gold also prove more yielding; whereas in iron, the entrance of the menstruum is violent, and attended with a conflict, the parts of the iron making a much greater resistance.

* This is easily tried in a common candle, where, if a piece of packthread, or a splinter of wood, be thrust into the centre of the flame, the point will remain for a while unburnt, whilst the outermost part, in contact both with the flame and air, readily takes fire and burns away. Hence flame appears to be a kind of film, or conical surface, whose inside is filled with the smoke of the fuel. Let the common instances be here remembered of sealing-wax, &c. smoked by being held too far in the flame of the candle.—See Dr. Hook's Lectures of Light, and Boerhaave's Chemistry, under the Chapter of Fire.

† See Dr. Hook's Lectures of Light, and Micrographia, passim.

‡ See Tab. I. Instance 27.

‖ Observe how the Author, according to his own rule, proceeds to limit the particular motion, which, as a true genus, is to constitute the form of heat.—See Aph. 4.

(29.) Lastly, it appears also, in some measure, from such gangrenes and mortifications of the flesh, as cause no great heat or pain, by reason of the subtilty of the putrefaction.* And let this serve for what we call the first vintage, or an attempt towards interpreting the form of heat, which the understanding makes, as we said, by the way of permission.†

(30.) The fruit of this first vintage is, in short, the following true definition, or form of heat, as it regards the universe, and not as it is only relative to the human sense, viz. heat is an expansive bridled motion, struggling in the small particles of bodies; but this expansion is modified, so that, whilst it spreads in circumference, it has a greater tendency upwards. It is also modified alternately, or by fits, so as to prove no way sluggish, but vigorous and active.‡

(31.) And, as to practice, the case is exactly correspondent, and amounts to this, that if in any natural body a motion can be excited which shall dilate or expand, and again recoil or turn back upon itself, so as that the dilation shall not proceed equably, but partly prevail and partly be checked, any man may doubtless produce heat, without at all regarding whether the body that is wrought upon be elementary, as they call it, or earthly, or whether it be enriched with a celestial influence; whether it be luminous or opake, rare or dense, locally expanded or contained within its original dimensions; whether it tend to dissolution or remain in its native state; whether it be animal, vegetable, or mineral; whether it be water, oil, air, or any other substance that is susceptible of the foresaid motion.‖ And heat, in respect of the sense, is the same thing, only with such relations as belong to sense. And this may serve as an example of our methods of investigating forms.§

* And these kind of gangrenes or mortifications may happen by cold or by freezing. See Mr. Boyle's History of Cold, passim.

† See Aph. 36. The meaning is, that, as men are apt to grow weary of prosecuting inquiries, where they reap no quick advantage, or receive no immediate fruits of their labours, the understanding is permitted to gratify itself by a kind of anticipation, or by making some offer and first attempts at discovering the forms of things; but, till the inquiry is duly prosecuted, men have no right to pronounce, or even to expect, that the forms of things can be perfectly discovered.

‡ Here we have an instance of a genuine or scientifical definition, which is no other than the form or nature of the thing defined, so that the true definitions are the results of inquiries duly prosecuted, and not those slight arbitrary notions usually called by the name of definitions.

‖ Hence we are furnished with a farther criterion, or argument, *a posteriori*, that will shew, in fact, whether the form be justly discovered. Thus if we can produce heat in all bodies susceptible thereof, by introducing into them the motion here described, we shall have a confirmation that this motion is the form of heat; and the only exception in practice is, perhaps, water, for introducing heat into which, by the means of this particular motion, a well-adapted mechanical contrivance seems hitherto wanting, though possibly it might with ease be supplied.

§ Though this method is here so fully delivered, and promises better things than possibly any other method of inquiry hitherto known yet it appears strangely to be disregarded. And, certainly, it should seem as if very few were apprized that this method, thoroughly pursued, is an actual demonstration, as justly and properly suited to physics, or indeed to all philosophy, as mathematical demonstration and algebra are to geometry and general mathematics.

NOVUM ORGANUM.

PART II.—SECTION II.

THE DOCTRINE OF INSTANCES; OR, THE METHOD OF EXPEDITING THE INTERPRETATION OF NATURE AND THE INVESTIGATION OF FORMS BY PREROGATIVE INSTANCES.*

APHORISM XXI.

HAVING thus laid down the Tables that afford the first view of a subject,† and given an example of the method of rejection or exclusion, and a specimen of the fruits, or first dawn of doctrine, to be derived from them, we proceed to the other helps of the understanding in the business of interpreting nature, or forming a true and perfect induction; and, in proposing these helps, we shall, wherever tables are required, proceed upon the foregoing subject of heat;‡ but where fewer examples are sufficient, we will occasionally launch into subjects of all kinds, without confounding our inquiry of heat on the one hand, or confining our doctrine to too scanty bounds on the other.‖

We therefore propose to treat, 1, of prerogative instances; 2, of the helps of induction; 3, of the rectification of induction; 4, of the method of varying inquiries, according to the nature of the subject; 5, of prerogative natures for inquiry, or what subjects are to be inquired into first, what second; 6, of the limits of inquiry, or an inventory of all the natures in the universe; 7, of reducing inquiries to practice, or making them subservient to human uses; 8, of the preliminaries to inquiry; 9, and lastly, of the ascending and descending scale of axioms.§

* The doctrine of instances is delivered with great diligence, sagacity, and exactness, in the present Section. The design is to shew what are the principal, most material, and essential, particulars in every inquiry, or what instances are chiefly to be sought after and regarded, in order to discover the real natures of things with the greatest certainty and expedition. It is a doctrine of the first importance in the discovery of forms, and for want thereof the philosophical inquiries we generally meet with are but light skirmishes, instead of close grapplings with nature, or, without a metaphor, they have no strong and direct tendency to the discovery of forms, but appear vague, indetermined, and rather amusing than useful.

† That is, in the way of example, and not in the way of a rigid and just inquiry, which requires much more industry and exactness, after the manner of the Author's inquiry into the subjects of Life and Death, Winds, Condensation, and Rarifaction; though these also are but a kind of larger examples, and not finished inquiries.

‡ The Tables for that purpose being laid down in the preceding Section.

‖ And in this view the following Aphorisms will exhibit a little map of the roads for improving all kinds of knowledge.

§ Of these nine general heads, under which the remaining parts of the Novum Organum were to have been comprized, no more than the first is prosecuted by the Author.

22. Among the prerogative instances for interpreting nature, in the first place come the solitary kind;* that is, 1, those which exhibit the nature inquired after in such subjects as have nothing common with others besides that very nature; or, 2, those that exhibit the nature inquired after in such subjects as are every way similar to others, excepting in that very nature; for it is manifest that such instances as these will shorten the inquiry, and promote and hasten the exclusion,† so that a few of them may do the service of many.

For example, 1, if the inquiry be about the nature of colour, solitary instances are prisms and crystal gems, or glasses, which represent colours, not only in themselves, but also externally upon a wall, &c. Understand the same of dews, &c. for these have nothing in common with the fixed colours of flowers, coloured gems, coloured glass, metals, various woods, &c. besides the colour itself. Whence it may be easily inferred, that colour is nothing more than an alteration in the rays of light, occasioned, in the first case, by different degrees of incidence,‡ and in the second by the different texture or structure of the body, and so reflected to the eye; but these instances are solitary or single in point of likeness.‖

(2.) Again, in the same inquiry, the distinct veins of black and white in marble, and the variegation of colours in flowers of the same species, are solitary instances, for the black and white parts of marble, or the spots of white and purple in carnations, agree almost in every respect except in colour. Whence it is easily collected that colour does not greatly depend upon the intrinsic nature of the coloured body, but is owing to a somewhat gross or bare mechanical texture of the parts.§ Thus these instances are solitary in point of difference, and we call both the kinds by one and the same name.

23. In the second place come travelling instances, or those wherein the nature inquired after travels or advances to generation, when it was not before in being; or, on the contrary, travels, or tends to destruction, when it was in being before; and, therefore, in either corrolative, such instances are always duplicate, or rather one instance, in motion or passage, is continued to the opposite period;** and instances of this kind not only

Nor was any thing afterwards published towards executing the rest, though it appears that the whole design was laid from the first, and that at times the other parts were gone on with, after the present piece was published. The want of these additional Sections may, perhaps, be in some measure supplied by a close attention to the present Doctrine of Instances; but, in order to render the whole more generally intelligible and useful, it were greatly to be wished that some tolerably-qualified person would give an Essay upon it, in as familiar a manner as the subject will allow.—See Dr. Hook's Method of improving Natural Philosophy.

* Let it be remembered, that, with regard to the names of the several kinds of instances hereafter mentioned, the author had a right to impose them, as the subject was entirely new and untouched; and, doubtless, certain definitions and names are required where things are to be carefully distinguished.

† See Table IV. Aph. 18.

‡ Viz. In the prism, glasses, dew, &c. Which kind of instance led the Archbishop of Spalato, Dr. Hook, Mr. Boyle, Sir Isaac Newton, &c. to very considerable discoveries in the subject of colours.

‖ Viz. Dissimilar in all respects besides that of colour, in which the solitariness of the instance consists.

§ See Mr. Boyle of Colours.

** That is, either there is both a generation and destruction, or else one and the same process begins with generation and ends with destruction.

accelerate and confirm the business of exclusion, but also drive the affirmation, or form itself, into a narrow compass; for the form of the thing must necessarily be somewhat introduced or abolished by this transmigration; and, though all exclusion promotes and forwards the affirmation, yet this is more directly done in the same subject than in different ones; for it plainly appears, from all we have said before, that the form discovering itself in one thing leads to its discovery in all the rest; but the more simple this passage is, the nobler the instance should be esteemed.

Again, these travelling instances are of great use in practice, because, as they exhibit the form joined with an efficient or privation,* they clearly design or mark out the practical operation in some cases, whence an easy passage is also afforded to the neighbouring discoveries. There is, however, some danger in these instances that requires a particular caution, for they may be apt to restrain the form too much to the efficient, and to infect, or at least to tinge, the understanding with a false notion of the form, through an apparent mixture of the efficient, whereas the efficient is never more than the vehicle of the form.† But this inconvenience is easily remedied by making a just exclusion.‡ To give an example of a travelling instance, suppose the nature inquired after were whiteness, an instance advancing to generation‖ is glass, whole and in powder; and again, simple water and water beat into froth, for whole glass and simple water are transparent bodies, not white, but powdered glass and the froth of water are white, not transparent. It comes, therefore, to be inquired, what has happened to the glass or water in this transmigration,§ for, it is manifest that the form of whiteness travels, or is conveyed over by pounding the glass and agitating the water, but nothing is here found added, besides a bare comminution of the parts of the glass and the water, together with the interposition of the air. And it is no small acquisition in discovering the form of whiteness, that two bodies, of themselves more or less transparent, viz. air and water or air and glass being mixed together, in subtile or small parts, should exhibit whiteness, by differently reflecting the rays of light.**

We must also give an example of the danger and caution above-mentioned, for it may here readily occur to the understanding, depraved by these kinds of efficients,†† that air is always necessary to the form of whiteness, or that whiteness is generated only by transparent bodies; which two positions are absolutely false, and rejected by numerous exclusions.‡‡ It will rather appear, without the interposition of the air,

* See Part II. Sect. I. Aph. 1, 4, &c.

† See Part II. Sect. I. Aph. 2, &c.

‡ See Table IV. Aph. 18.

‖ Viz. The generation of whiteness.

§ Viz. From trasparency to whiteness.

** See Mr. Boyle's History of Colours, Dr. Hook's Lectures of Light, and Sir Isaac Newton's Optics, passim.

†† Such as the pounding of glass, the agitating of water, &c. upon which the transparency ensues.

‡‡ According to the procedure of Table IV. Aph. 18.; thus ceruse is made of lead, an opake pulpy mass makes white paper, &c.; white minerals are found in the earth, white enamels are made in the fire, &c.

&c, that the bodies perfectly uniform or similar in their optical parts prove transparent; that those which have the simple texture, or arrangement of their parts disturbed, are white; that a dissimilarity in the regular texture of bodies affords all colours, except black; and that a dissimilarity in a compound absolutely irregular and confused texture constitutes blackness.* And, for an instance advancing to destruction in the same nature of whiteness, we have it in froth subsided, or snow dissolved, for water deposits its whiteness and puts on transparency, upon becoming entire, without any intermixture of air.

We must by no means omit, that, under travelling instances, should be comprehended not only those which travel to absolute generation and privation, but such likewise as travel to a greater or less degree of the nature sought, since these also tend to the discovery of the form, as plainly appears, both from the definition of a form, above laid down,† and the Table of Comparison;‡ and, therefore, the instance of paper, which is white when dry, but proves less white when wet, and comes nearer to the state of transparency upon the exclusion of the air and the reception of the water, is of the same use as the instances above-mentioned.‖

24. (11.) Among the prerogative instances come in the third place the glaring kind, mentioned in our first dawn of doctrine from the form of heat,§ which we also call by the name of shining, released, or predominating instances. And these are such as shew the nature searched after, naked and standing alone, and this in an eminent manner, or in the highest degree of its power, as being disenthralled and freed from all impediments; or at least, by the strength of its own virtue, over-ruling, conquering, and subduing them; for, as every body may receive many united and concrete forms of natures, it happens that one may repel, depress, break, and bind down another, whence all particular forms are obscured. But there are certain subjects wherein the nature sought after appears more in its vigour than in others, either through the absence of impediments or the predominancy of its own virtue. — And instances of this kind are what principally shew the form; but in these also caution must be used, and the alertness of the understanding be repressed; for, whatever boasts the form and obtrudes it, so that it seems to meet the understanding, should be held suspect,** and recourse be had to a careful and severe exclusion.††

For example, if the nature inquired after be heat, then the weather-glass is a glaring instance of the expansive motion, which is, as we said above, a principal part of the form of heat;‡‡ for flame, though

* Perhaps these intimations carry the inquiry into the causes of colours on the side of the coloured body farther than has been generally followed. — See Mr. Boyle, of Colours, and Sir Isaac Newton's Optics.

† See Aph. 4. ‡ See Aph. 13.

‖ Viz. The whiteness and transparency of glass, water, &c. this latter being a kind of intermediate instance betwixt the former.

§ See Aph. 20.

** ...s being very apt to deceive, for men have reason to be assured, that the forms of things are not easy to find. And let it be duly weighed and considered, how many certain instances there are of a true and perfect discovery of forms.

†† See Tab. IV, Aph. 98.

‡‡ See Aph. 12, (37) 20, ad finem.—See Tab. I. II. III. IV. and V.

it manifestly shews an expansion, yet, by reason of its momentary extinction, it does not exhibit the progress thereof.—Again, boiling water, because of the easy transition of the water into vapour and air, does not so well shew the expansion of the water in its own body.—Again, ignited iron and the like bodies are so far from shewing the progress, that, on the contrary, the expansion itself is not visible to the sense, by reason of the re-action and breaking of the spirit in the compact and gross part;* but the weather-glass clearly and evidently shews a true progressive and durable expansion of the air by heat.†

For a second example, let the nature required after be gravity, and then quicksilver will prove a glaring instance, as having a far greater specific gravity than any thing else, except gold, which, however, is not much heavier, but quicksilver is a better instance for disclosing the form of gravity than gold, because gold, being a solid and consistent body, its superior gravity may seem owing to its solidity, whereas quicksilver is fluid and full of spirit, and yet proves much heavier than diamond or any other of those bodies that are esteemed the most solid, whence it appears that the form of gravity or weight resides simply in the quantity of matter, and not in solidity, firmness, or hardness of texture.

25. In the fourth place come those we call clandestine instances, or instances of twilight, which are in a manner opposite to glaring instances, as shewing the nature inquired after in its weakest virtue and imperfect state, or rudiments, striving, or, as it were, first attempting to manifest itself, whilst it remains covered and subdued, or kept under by a contrary nature; and there are instances of extraordinary service in the discovery of forms; because, as the glaring instances easily lead to differences, so the clandestine instances easily lead to kinds, that is, to those common natures of which the natures inquired into are no other than limitations.‡

For example, let the nature inquired into be consistence or solidity, the contrary of which is liquidity or fluidity, then clandestine instances are such as exhibit some faint and low degree of consistency in a fluid; suppose a bubble of water, which is a kind of consistent and determinate pellicule, made of the body of the water. In like manner, icicles, if there be water to follow them, lengthen themselves out in a very slender thread, to prevent a discontinuity of the water; but, if there be not a sufficient quantity to follow, the water then falls in round drops, which is the figure that best supports it against discontinuation; and, at the very instant when the thread of water ends, and the falling in drops begins, the water recoils upwards to avoid being discontinued. So in metals, which are fluid upon fusion, though a little tenacious, some of the mettled mass frequently springs up in drops, and sticks in that form to the sides of the crucible. There is a like instance in the looking-glasses commonly made of spittle by children, in a loop of rush or whalebone, where we find a consistent pellicule of water. But this is observed to much better advantage in that other diversion of children, when they take strong soapy water and blow in it with a pipe,

* All the five preceding Tables are to be consulted on this occasion.

† See Table II. III. (37.)

‡ See Part II. Aph. 4.—Whence it will evidently appear of what great use these instances are.

so as to raise the water into a tower or castle of bubbles, whilst, by the interposition of the air, the soapy water becomes consistent to that degree as to be thrown a considerable distance without breaking. This also appears to advantage in froth and snow, which put on such a consistency, that they may be almost cut with a knife, though they are but bodies formed of air or water, both of them fluid. These several instances seem clearly to intimate that fluidity and consistency are no more than vulgar notions relative to the human sense, and that all bodies have a real appetite to avoid discontinuation, though in homogeneous bodies, such as fluids are, it is but weak and feeble, whilst in those compounded of heterogeneous matters, it proves more strong and powerful, because the application of what is heterogeneous binds bodies up, but the entrance of what is homogeneous relaxes and dissolves them.*

As a farther example, if the nature sought were attraction, or the appetite of approach in bodies, a most remarkable glaring instance, as to the discovery of the form, is the loadstone; the contrary of an attractive nature is an unattractive nature, though in a similar substance, as in iron, which does not attract iron; nor does lead attract lead, nor wood attract wood, nor water attract water. But the loadstone armed with iron, or rather the iron of an armed loadstone, is a clandestine instance; for here it happens, that an armed loadstone does not, at a certain distance, attract iron stronger than an unarmed loadstone; but if the iron be moved so near as to touch the iron of the armed loadstone, then the armed loadstone will support a much greater weight of iron than the naked and unarmed loadstone, by reason of the similitude of substance betwixt iron and iron, which operation was altogether clandestine and secret, or concealed in the iron before the loadstone was applied. Whence it is manifest, that the form of attraction is a thing that is vivid and strong in the loadstone, but weak and latent in iron.

After the same manner, it is observed, that headless arrows of wood, being fired out of a gun, will penetrate farther into wood, or the sides of a ship, than the same arrows headed or pointed with iron, by reason of the similitude of substance betwixt wood and wood,† though this before lay concealed in the wood.

Again: though air does not manifestly attract air, nor water manifestly attract water, in a state of entireness, yet one bubble approaching another makes it easier dissolve, than if the other bubble were away, by reason of the appetite of conjunction between water and water, and between air and air.

And this kind of clandestine instances, which, as we before observed, have a noble use, are most remarkable in the small and subtile parts of bodies, because the greater masses of things follow the more general and universal forms.‡

26. In the fifth place, come constituent or collective instances, that is, such as constitute one species of a nature inquired after in the way of a smaller form; for, as genuine forms, which are always con-

* Consider the instances derivable from chemistry and the doctrine of menstruums.

† Is the fact certain?—See the Sylva Sylvarum.

‡ We have here a remarkable opening in the doctrine of attraction. — See Sir Isaac Newton's Principia and Optics, passim.

vertible with the natures sought,* lie deep, and are not easily found, the design itself and the weakness of the understanding require that partial forms, which are collective of certain packets of instances, (though by no means of all,) into some common notion, should not be neglected, but carefully observed; for, whatever collects and unites natures, though it be but imperfectly, paves the way to the discovery of forms; and, therefore, those instances which are useful to this purpose have a considerable power and a prerogative nature.

But great caution must here be employed, lest the understanding, after having found many of these particular or partial forms, and hence made arrangements or divisions of the nature sought after, should wholly rest in them, and not apply itself to the legitimate discovery of the great form, but pre-suppose nature to be manifold and divided, as it were, in the root, and therefore disdain and reject all farther uniting of her, as a matter of needless subtilty, and tending to mere abstract speculation.

For example, let the nature sought be memory, or the means of exciting or helping the memory, the constituent instances will here be, first, order, or distribution, and places for artificial memory. Order, or distribution, manifestly assists the memory; and places for artificial memory may either be places in a proper sense, as a door, a window, a corner, &c. or familiar and known persons, or any other things at pleasure, provided they be placed in a certain order, as animals, plants, words, letters, characters, historical personages, &c. though some of these are more and some less fit for the purpose. — But such kind of places greatly help the memory, and raise it far above its natural powers. Again, verse is easier learnt and remembered than prose.

And this collection or packet of the three above-mentioned instances, viz. order, artificial place, and verse, constitute one species of help for the memory; and this species of help may be justly called the prevention of endless search; for, when a person endeavours to recollect, or call a thing to mind, if he has no previous notion or perception of what he is in quest of, he casts about, and tries every track, as it were, without end; but, if he have any previous notion, this infinity of search is presently cut short, and the memory is brought to hunt nearer home. But in the three instances above-mentioned, there is a clear and certain previous notion contained; for, in the first, there is required somewhat agreeable to order; in the second, an image is required that has some agreement or relation to those fixed places; in the third, words that will stand in a verse; so that infinity is thus cut off or prevented, and the search limited and restrained.

Other instances will give this second species, that, whatever brings an intellectual thing to strike the sense, (which is the method principally used in artificial memory,†) helps the remembrance.

Other instances will give this third species, that those things which make an impression by means of a strong affection or passion, as by causing fear, surprize, blushing, delight, &c. assist the memory.

Other instances will give this fourth species, that those things sink deepest, and dwell the longest in the memory, which are chiefly impressed upon a clear mind, that remains unprejudiced, either before or

* See Part II. Aph. 4.

† See the Art of Memory, in the de Augment. Scientiar. Sect. XV.

after the impression, as the things we learn in childhood or think of just before going to sleep, as likewise all the first times that things are taken notice of.

Other instances will give this fifth species, that a multitude of circumstances, or, as it were, handles, or holds to be taken, help the memory, as the making of many breaks in writing or printing, reading or repeating aloud, &c.

Lastly, other instances will give this sixth species of help, that those things which are expected and raise the attention, stick better than such as pass slightly over the mind; whence, if a man should read a writing twenty times over, he would not remember it so well, as if he should read it but ten times, with trying between whiles to repeat, and consulting the copy where his memory failed.

Hence there are, as it were, six smaller forms of helps for the memory, viz. (1.) the cutting off infinity; (2.) reducing intellectual to sensible things; (3.) impression by a strong passion; (4.) impression upon a mind free and disengaged; (5.) variety of handles, or occasions; and, (6.) expectation conceived.

In like manner, let the nature sought be taste, or tasting, and the following instances are constituent, viz. (1.) those who naturally want their smell, do not perceive or distinguish by the taste such meats as are musty or tainted; or again, such as are mixed with garlick, roses, and the like.

(2.) Those who have their nostrils obstructed, by the accidental falling down of a rheum, do not distinguish or perceive things that are putrefied, musty, or sprinkled with rose-water.

(3.) If those who are troubled with this kind of rheum, hold any fœtid or perfumed thing in their mouth, and at the same time strongly blow their nose, they immediately perceive the stench or perfume.

These instances will afford or constitute this species, or rather part of the form of taste, viz. that the sense of tasting is, in some measure, no more than an internal smell, passing and descending from the upper cavities of the nostrils to the mouth and palate.

(4.) On the contrary, saltness, sweetness, acrimony, acidity, roughness, bitterness, &c. are all perceived, as well by such persons as want their smell, or have it obstructed, as by any others, which shews that the sense of taste is a certain composition of an internal smell, and a kind of an exquisite touch;* but this is no place to prosecute the subject.

Again, for example, let the nature sought be the communication of quality without commixture of substance. The instance of light will here afford or constitute one species of communication, and heat and the loadstone another; for the communication of light is, in a manner, momentary, and ceases immediately upon removing the original illuminating body; but heat and the magnetic virtue, when communicated, or rather excited, in any body, lodge and remain therein for a considerable time after the first cause is taken away.

Lastly, these constituent instances have a very high prerogative, as being eminently serviceable in the forming of definitions, especially the particular kind, and again in the making of divisions, or distribu-

* See the Sylva Sylvarum, p. 155, 180, &c.

tions of natures, with regard to which Plato said well, that he is to be held as a god who knows perfectly how to define and divide.*

27. The sixth place may be assigned to those instances which we call parallel, conformable, or proportional instances, and sometimes physical parallels and similitudes; that is, such as shew a similitude, correspondence, and relation, betwixt things; not in the smaller forms, like constituent instances,† but entirely in the concrete; and are, therefore, as it were, instances of the first and lowest degree, for the uniting of nature;‡ nor do they constitute any axiom immediately from the beginning, but only point out, indicate, or present, certain relations of bodies; and, although these instances are of no great use in the disclosing of forms, yet they very advantageously lay open the structure of the parts of the universe, or make a kind of anatomy in the members thereof, and therefore sometimes lead up to sublime and noble axioms, especially such as belong to the configuration of the world rather than to simple natures and forms.‖

For example, parallel or conformable instances are such as these, viz. a speculum and the eye, the structure of the ear, and of the cavernous places that yield an echo, &c. from which conformity, besides the observation of the similitude or correspodence, (which is useful in many respects,) it is easy to form and collect this axiom, that the organs of the senses, and the bodies that procure reflections to the senses, are of a like nature.

And again; the understanding, being thus admonished, easily rises to a still higher and more noble axiom, viz. that there is no difference between the consents, or sympathies, of bodies endowed with sense, and those of inanimate bodies without sense, only that in the former an animal spirit is added to the body so disposed, but is wanting in the latter, whence as many conformities as there are among inanimate bodies, so many senses there might be in animals, provided there were organs or perforations in the animal body for the animal spirit to act upon the parts rightly disposed, as upon a proper instrument.

And conversely, as many senses as there are in animals, so many motions there may be in bodies inanimate, where the animal spirit is wanting, though there must, of necessity, be many more motions in animate bodies, because of the small number of the organs of sense.

And of this we have a manifest example in pains; for, as there are numerous kinds of pains in animals, and, as it were, different characteristics thereof, there being one pain of burning, another of freezing, another of pricking, another of squeezing, another of stretching, &c. it is certain that all these, with regard to the motion, exist in bodies

* This use will appear evident, by recurring to the beginning of the present Aphorism; and, without frequently going back, and comparing one part of these Aphorisms with another, it cannot be expected that their doctrine and use should be fully comprehended.

† See Aph. 26.

‡ Viz. For discovering the similarity, sameness, or unity, of nature, in dissimilar subjects.—See Part II. Aph. 3.

‖ This and the like general descriptions of instances will be usually intricate and abstruse of themselves, till the subsequent exemplifications are read, which render the whole plain and intellible; whence, after reading the examples, it may be proper to go over the general description again, in order the better to take the sense and observe the correspondence.

inanimate as they do in animate bodies, for example, in wood or stone, when burnt, frozen, pricked, cut, bent, bruized, &c. though there be no sense attending them in these inanimate bodies, for want of the animal spirit.*

Again, the roots and branches of plants, though this may seem strange, are conformable instances; for, every vegetable swells and thrusts out its parts towards the circumference, as well upwards as downwards, and the difference betwixt the roots and the branches is no more than this, that the root is contained in the earth but the branch exposed to the air and sun.

For, if a young thriving branch of a tree be bent down into any parcel of earth, though it does not reach to the ground, it will soon become a root; and again, if earth be laid on the top of a plant, and be so pressed down by a stone or other hard substance that the plant cannot grow upwards, it will shoot out branches downwards into the air.†

The gums of trees and most gems of the rock are also conformable instances, both of them being no other than exudations and percolations of juices; for gums are but the transuded juices of trees, and gems the transuded juices of stones, whence the clearness and transparency of them both are procured by means of a curious and exquisite percolation.‡ And hence it is that the hairs and furs of animals are not of such beautiful and vivid colours as many feathers of birds, viz. because the juices are not so subtily strained through the direct skins of beasts as through the substance of the quill in birds. The scrotum also in male animals and the matrix in female are conformable instances, so that the noble structure which distinguishes the sexes in land-animals seems to be nothing more than a difference as to external and internal; because, by a greater force in heat, suppose the genital parts in the male sex are thrust outwards, whilst the heat is too feeble in females to effect such an extrusion, whence those parts in them come to be contained within.

Among conformable instances also come the fins of fish, the feet of quadrupeds, and the feet and wings of fowl, to which Aristotle adds, four wreaths of serpents,‖ so that, in the structure of the universe, the motion of living creatures seems generally performed by quadruple limbs or flexures.

Again, the teeth in terrestrial animals and the beaks in birds are conformable instances, which shew that in all perfect animals, a certain hard substance flows to the head.§

It seems also no absurd similitude or conformity that man should resemble an inverted plant, the root of the nerves and animal faculties residing in the head, and the seminal parts being seated below, if we do not take in the extremities of the legs and arms; but in a plant, the

* See the Sylva Sylvarum, under the article Spirits, &c.

† See the experiments upon Vegetation in the Philosophical Transactions, French Memoirs, and the Author's Sylva Sylvarum.

‡ See the Article Percolation in the Sylva Sylvarum.

‖ Are there but four wreaths made in the progressive motions of snakes, vipers, &c.? Consider, also, the motions of caterpillars, worms, &c.

§ See the Sylva Sylvarum, under the articles Bones and Teeth.

root, which answers to the head in a man, is regularly placed below and the seeds above.*

But this precept cannot be too frequently inculcated, that the procedure and method of mankind in their inquiries and endeavours to collect a natural history must be entirely altered from the method at present in use, for men's curiosity and diligence have been hitherto principally employed in observing the variety of things, and explaining the precise differences of animals, vegetables, and fossils, the greatest part of which variety and differences are rather the sport of nature than matters of any considerable and solid use to the sciences. Such things, indeed, serve for delight, and sometimes contribute to practice, but afford little or no true information or thorough insight into nature; human industry, therefore, must be bent upon inquiring into and observing the similitudes and analogies of things, as well in their wholes as in their parts, for these are what unite nature,† and begin to build up the sciences.

But here a severe and rigid caution must be used, that those instances only be received for conformable and proportional, which (as we all along require,‡) denote real physical likenesses and resemblances, that is, such as are true, substantial, and actually lodged and seated in nature, not such as are accidental and showy, much less such as are superstitious or vain, like those which the writers of natural magic, (a vain set of men, that scarcely deserve to be mentioned in the serious subject we are now upon,) every where boast of in describing, and sometimes with great levity and vanity feigning empty similitudes and sympathies.

To proceed: conformable instances are not to be neglected in the configuration of the world itself, with regard to its larger parts. Thus Africa and Peru, with the Continent up to the streights of Magellan, have similar isthmuses and similar promontories, which does not happen without some cause.

So again, both the old world and the new are wide and extended towards the north, but narrow and pointed towards the south.

But among the noblest instances of conformity come the intense cold in that called the middle region of air, and the violent fires often found to break out from subterraneal places, for these two things are extremes and limitations, the one limiting the nature of cold towards the arch of the heavens, and the other limiting the nature of heat towards the bowels of the earth, by antiperistasis, or the rejection of a contrary nature.

Lastly, a conformity of instances deserves to be observed in the axioms of the sciences. So the figure in rhetoric, called inexpectation, when a matter comes in unexpectedly, is conformable to that figure in music which is called sinking of the cadence.‖ So again, the mathematical postulate that things equal to the same third are equal among themselves, is conformable with the structure of a syllogism in logic,

* Animals likewise appear to resemble inverted plants in another respect, viz. in having their roots within, whilst plants have them without, for the lacteal veins in animals nearly correspond with the fibres of the roots in plants, so that animals seem nourished from within themselves, as plants are from without.

† See Part II. Sect. I. Aph. 3.

‡ See Part II. Aph. 1, 4, 5, 20, &c.—See also hereafter, Aph. 33, ad finem.

‖ When the music drops, as it were, or sinks on the sudden.

which unites things agreeing in a middle term. To conclude, a certain sagacity in searching out and discovering physical conformities or similitudes is a very useful thing on many occasions.*

28. In the seventh place come those we term singular, irregular, or hetoroclite instances, borrowing the expression from the grammarians, that is, such as shew bodies in the whole or concrete, which seem to be out of course, or as if they were broken in nature, so as not to agree with other things of the same kind; for, conformable instances are like something else, but hetoroclite or singular instances, are only like themselves.

The use of these singular instances is the same as of clandestine instances; viz. for raising and uniting nature, so as to discover kinds, or common natures, that are afterwards to be limited by real differences.† Nor should the inquiry be dropt or broken off, till the properties and qualities found in such things as may be esteemed miracles in nature are reduced and comprehended under some form or certain law, so that all irregularity or singularity may be discovered to depend upon some common form, and the miracle only rest in the exact differences, degree, and extraordinary concurrence, and not in the species itself;—but the contemplations of men at present proceed no farther than to suppose such things as these to be secrets, great works of nature, and as it were causeless, and to make them exceptions to general rules.

As examples of singular instances, we have the sun and moon among the stars, the loadstone among stones, quicksilver among metals, the elephant among quadrupeds, the sense of venereal pleasure among the kinds of touch, and the scent of the blood-hound among the kinds of smell.

So with the grammarians, the letter S is held singular, for the easiness of its composition with consonants, sometimes with double, and sometimes with triple ones, which is a property of no other letter.

A large collection of such instances should be made, because they whet and quicken the inquiry, and also rectify and cure the understanding, depraved by custom, and things of common occurrence.‡

29. In the eighth place come deviating instances, that is, the errors of nature, and things monstrous and uncommon, where nature turns aside from her ordinary course; for, the errors of nature differ from singular instances in this, that singular instances are miracles in species, but errors of nature are miracles in individuals; though these deviating instances have nearly the same use with the former as tending to rectify the understanding, depraved by the things to which it is most accustomed, and to disclose the most common forms, for here also the inquiry is not to cease, till the cause of the deviation be discovered, though this cause does not properly rise to any form, but only to the latent process‖ that leads towards it; for, as he who knows the ways of

* See the *De Augment. Scientiar.* p. 70.—See also the Sylva Sylvarum, passim. particularly under the article Sound.

† How far this contributes to the investigation of forms may appear from Aph. 4, Sect. I. Part II.

‡ Let it be all along observed, and carefully remembered, that this whole doctrine of instances lays down precepts for conducting inquiries, both general and particular, with a direct view to the investigation of forms or the full interpretation of nature; and, in the light of this intimation, the Author's larger inquiries are also to be considered.

‖ See Part II. Sect. I. Aph. 1, 4, 5, &c.

nature, will the easier observe her deviations, so he who knows her deviations will more exactly describe her ways.

They differ in this also from singular instances, that they conduce much more to practice than those, for it would be very difficult to generate new species, but it is easier to vary the known species, and thence to produce many extraordinary and unknown things, there being a ready passage from the miracles of nature to the miracles of art; for, if nature shall once be discovered in her variation, and the reason of it become manifest, it will be easy to lead her thither again by art, where she erred by accident; and that not only in one case, but in others, for errors on one side shew and open the way to errors and deviations on all sides.

And here examples are not necessary, because they are so numerous and common. But a collection or particular natural history should be made of all prodigious and monstrous births and productions of nature; and of all things new, extraordinary, and uncommon, in the universe; but this is to be done with the strictest and most judicious choice, so that it may be safely relied on. And here those things are principally to be held suspect, which in any sort relate to religion, as the prodigies of Livy, and those no less which are found in the writers of natural magic, alchemy, or other writers of the like kind, who are the professed admirers, or, as it were, adorers, of fable and fiction. But all the particulars for this purpose are to be derived from grave, judicious, and faithful, history and just relation.

30. In the ninth place come frontier instances, which we sometimes also call participles.* These are such as exhibit those species of bodies which seem composed of two species, or to be rudiments betwixt one species and another, but these instances may be justly reckoned among the singular or heteroclite kind, as being rare or extraordinary in the universe, yet for their dignity they ought to be separately placed and treated; for, they excellently indicate the composition and structure of things, and suggest the causes of the number of the ordinary species in the universe, and lead the understanding from that which is to that which may be.

Examples of these are, (1.) moss, which is something betwixt putrefaction and a plant; (2.) certain comets, which are of a nature betwixt stars and fiery meteors; (3.) flying-fishes, which are a species betwixt birds and fishes; (4.) bats, which are betwixt birds and quadrupeds; (5.) the beast so like ourselves, the ape;‡ (6.) the biformed births of animals; (7.) the mixture of different species, &c.‖

31. In the tenth place come instances of powers, or, as we sometimes call them, trophies or ensigns of power, inventions, or the works of men's hands, that is, the most noble and perfect works, and, as it were, the masterpiece in every art; for, since the design is to bend nature to

* From their participation of two different natures, as a participle in grammar participates of a noun and a verb.

† See Aph. 28.

‡ *Simia quam similis, turpissima bestia, nobis.*

‖ Viz. Mules, mongrels, dogs by the mixture of a dog and a fox, and the like in other beasts, birds, and fish, where the instances can be found.

things, and bring her to serve the turn of man;* it is absolutely proper that the works already in men's possession should be enumerated and set down, (as so many provinces already subdued and cultivated,) especially such works as are best understood and brought nearest to perfection; because these afford a short and easy passage to farther discoveries; for, if any one, after an attentive consideration of the works already extant in this kind, would determine to use his best and strongest endeavours, he might doubtless either carry them somewhat farther, or convert them to some other obvious purpose, or apply and transfer them to more noble uses than were known before.†

Nor is this all; but as by extraordinary and uncommon or miraculous works of nature, the understanding is rouzed, excited, and elevated, to the discovery of the forms capable of producing them;‡ so the like is done by the wonderful and extraordinary works or miracles of art, but in a much greater degree, because the manner of effecting, producing, and working, such miracles of art, is generally plain, whereas miracles of nature are commonly more obscure and dark; but here the greatest caution is required, that such miracles of art may not depress the understanding, and fix it, as it were, to the earth.

For there is danger, lest in these works of art, which appear like so many ultimate perfections and utmost stretches of human industry, the understanding should be captivated, chained down, or, as it were, enchanted with them; so as not to converse with other things, but imagine that nothing of the same kind can possibly be effected in any other way, and that no farther improvement can be made, except by operating in the same way with greater diligence, exactness, and a better apparatus.

On the contrary, this is to be held certain, that the ways and means of effecting the things and works hitherto discovered and described are generally scanty and defective, and that all greater power and ability depend and are regularly deducible from the fountain of forms, not one whereof is hitherto discovered.||

And, therefore, as we formely observed, though a man should ever so thoroughly have studied the nature of the warlike engines and battering rams of the ancients, or even have spent his whole life in the inquiry, yet he would never have fallen upon the invention of ordnance and gunpowder, no more than he who should have employed his obser-

* Let a clear and strong conception be had of the end in view, which is no less than to acquire such a command and mastery over nature, as that men may use her like a ready instrument or agent in effecting the greatest works, such as lengthening life, ruling the weather, and the like, which, to vulgar philosophers, appear impossibilities.

† This directs us to a short and facile method of improving the known arts and inventing new ones. See the Section upon Learned Experience in the *De Augmentis Scientiarum*.

‡ For every thing producible is produced by its form. See Part II. Aph. 4. and the first section throughout. This point being absolutely fundamental, and of the very utmost importance, cannot be too often inculcated or too well understood; for in this all the power both of men and nature centres.

|| Viz. Not according to the precise and infallible method of the Author, laid down and exemplified in the first section of this Second Part of his Novum Organum; and farther continued and improved in the present section, which, however, leaves the business imperfect, the completion of the whole being reserved for a third part of this general work.—See Aph. 21.

vations and thoughts upon the woollen and linen manufactures would have thence discovered the manufacture of silk.*

And hence all the more noble inventions will, if duly considered, be found owing, not to slender discoveries, applications, and enlargements, of arts, but entirely to chance or accident, whose slow and lingering motion, with which it creeps through ages, nothing can anticipate, prevent, or shadow out before-hand, but the discovery of forms.†

The things of this kind are so numerous as to need no particular instances. The direct business is, to visit and thoroughly inspect all the mechanic arts and all the liberal ones too, with regard to works, and thence to make a collection or particular history of the capital discoveries, master-pieces, and most perfect works in each, together with the ways of producing the effect, or the manner of every operation.‡

But we do not confine the diligence that should be used in this collection to things which are only judged master-pieces and secrets in any art, so as to raise the admiration, for admiration is the child of unfrequency, as whatever happens seldom, though in its kind but vulgar, yet produces wonder.

On the contrary, those things which ought to be admired, by reason of the differences of their species, compared with other species, are slightly passed over, if they are familiar and obvious; whereas the singularities of art are not less to be observed than the singularities of nature, mentioned above;‖ and, as among the singularities of nature we have placed the sun, and moon, the loadstone, &c. which, though very common things, are almost singular in their natures, the same is to be done in the singularities of art.

For example, paper, though a very common thing, is a singular instance of art; for, if well observed, artificial matters are either merely wove with direct and transverse threads, as silk, cloth, linen, &c. or made of concreted juices, as brick, clay, glass, enamel, porcelain, and the like, which, if well united, shine, but if less united, prove hard, but bear no polish; and all these latter substances, made of concreted juices, are brittle, and do not hold tenaciously together. — On the contrary, paper is a tenacious substance, that may be cut or torn, so that it resembles, and in a manner rivals, the skin or membrane of some animal, the leaves of some plant, or the like production of nature; for, it is neither brittle as glass, nor thready as cloth; and, though it has its fibres, yet it has no distinct threads, but exactly resembles the texture of natural matters, insomuch that the like can hardly be found again among artificial things, but it remains perfectly singular; and in artificial things, those, doubtless, are to be preferred which imitate and resemble nature the nearest, or which, on the other hand, powerfully govern, invert, or change her.§

Again, among instances of power, or the inventions and manual works of men, matters of dexterity, delusion, and diversion, are not

* See Part I. Aph. 109, 110.

† Let sufficient attention be given to this paragraph, for much depends upon it.

‡ This was the chief view and design of the Royal Academy of Sciences at Paris, viz. the describing the chief mechanical arts and trades of France, with the engines, instruments, tools, processes, and ways of working, made use of by the best masters.

‖ Aph. 29.

§ See the Sylva Sylvarum, passim.

to be rejected wholly, for some of these, though of small use, and only ludicrous, may yet be rich in information.

Lastly, neither are superstitious and commonly called magical matters to be quite excluded; for, although things of this kind lie strangely buried, and deep involved in falsehood and fable, yet some regard should be had to discover whether no natural operation is concealed in the heap; for example, in fascination, the power of imagination, the sympathy or consent of things at a distance, the communication of impressions from spirit to spirit, as well as from body to body, and the like.*

32. It appears, from what is above delivered, that five of the instances already mentioned, viz. (1.) the conformable, (2.) the singular, (3.) the deviating, (4.) the frontier instances, and, (5.) the instances of power, ought to be reserved, as the rest, before explained, and many of the following, ought to be, till any particular nature is inquired into; but a collection of them is immediately to be made from the beginning, as a certain particular history, in order to the digesting of the things which enter the understanding and correct the bad habit of the mind itself; for the mind must needs be tinged, infected, and at length perverted and distorted, by the daily and accustomed inroads and incursions made upon it.†

These instances, therefore, are to be employed as a certain preparative to rectify and cleanse the understanding;‡ for, whatever draws the understanding from the things whereto it is accustomed, at the same time lays it smooth and even, for receiving the dry and pure light of just ideas and notions. These instances also prepare and open the way to practice; as we shall shew hereafter.‖

33. In the eleventh place, come friendly or accompanying and hostile instances, which we call instances of fixed propositions. These are such instances as exhibit a body or concrete, wherein the nature inquired after constantly attends as an inseparable companion, or, on the contrary, wherein the nature sought perpetually absents and disappears, as a foe or enemy. And of this kind of instances, fixed, determinate, and general propositions, are formed, either negative or affirmative, wherein the subject will be a certain body in the concrete, and the predicate will be the nature sought.§ But particular propositions are by no means fixed, where the nature sought is fluctuating and moveable in any concrete, whether it be coming on or acquired, or again going off or deposited; therefore, particular propositions have no great prerogative, excepting only in the case of transmigration, of which we

* See the Articles Imagination and Sympathy in the Sylva Sylvarum.

† The meaning is, that, by constantly conversing with such things only as are common, familiar, and obvious, the mind acquires a strong bent or habit, whereby it judges that all things are conformable to these, and hence we frequently impose gross sophistry upon ourselves for truth, and argue and act in a strangely perverse and ignorant manner; whereas, before we can reason, judge, or philosopize truly, the mind must be acquainted and familiarized with things of agreeing, disagreeing, participating, singular, and extraordinary natures, as well as with those of the common, the obvious, and ordinary kind.—See the Doctrine of Idols, Part I. Aph. 38—61.

‡ Viz. From its Idols.

‖ See below, Aph. 50, of the present Section.

§ So, in the inquiry of heat, flame is the subject in the concrete, and heat the predicate, or nature sought.

spoke above;* yet even these particular propositions are of great use when confronted and compared with those that are universal, as we shall shew in its proper place;† but we do not require, even in these universal propositions, a rigorous or absolute affirmation or negation, they being sufficient for the purpose, though there should be some singular or rare exception to them.

The use of accompanying or friendly instances is to bring the affirmation of the form to a narrow compass; for, as in the travelling instances,‡ the affirmative of the form is contracted, so that the form of the thing must be found to be somewhat introduced or destroyed by the act of transmigration. After the same manner, in accompanying instances, the affirmative of the form is so pent up or confined, that it must necessarily be somewhat that may attend and enter such a concretion of body, or else fly from and shun it, whence he, who well understands the constitution or structure of this body, will not be far from disclosing the form of the nature sought.

For example, let the nature sought be heat, and an accompanying instance is flame; for, in water, air, stone, metal, and numerous other bodies, heat is moveable, and may come and go, but all flame is hot, so that heat perpetually attends in the concretion or whole of flame. — But there is no hostile instance|| of heat to be found; for, as to the internal parts of the earth, the sense has no cognizance thereof, but of all the bodies known to men, there is no concrete unsusceptible of heat.§

Again, let the nature sought be consistence, and air is a hostile instance;** for metal may flow and be consistent, so may glass, water likewise may be consistent when it is frozen, but it is impossible that air should ever be consistent, or put off its fluidity.

But there remain two admonitions with regard to these instances of fixed propositions, useful to the business in hand; the first is, that, if an affirmative or negative be universally and plainly wanting, this should be carefully noted as a non-entity, as we did in the subject of heat,†† where a negative, as to all the bodies within our knowledge, is universally wanting.‡‡

In like manner, if the nature sought be eternity, or incorruptibility, we have universally no affirmative upon this earth,|||| for neither can eternity or incorruptibility be attributed to or predicated of any substance below the celestial bodies, or above the internal parts of our globe.

* See Aph. 23.

† Which seems to be in the ascending and descending scale of axioms, which is wanting. See Aph. 21.

‡ See Aph. 23.

|| Viz. The converse of an accompanying instance.

§ See the Tables for investigating the form of heat.

** Because consistence always flies from air; or, in other words, always remains fluid.

†† See Tables II. and III.

‡‡ All the known bodies being, without exception, susceptible of heat.—See Table III. Aph. 20.

|||| That is, nothing here below is excluded from corruptibility and change.

The other admonition is, that, to the universal propositions, as well affirmative as negative, with regard to any concretes, those concretes also be subjoined,* which seems to approach nearest to that which is the non-entity; as, for example, in the subject of heat, the softest or mildest flames, or such as burn the least.† And again, in the subject of incorruptibility, gold, which comes the nearest to an incorruptible body, for all these things indicate the limits of nature, or shew the distance betwixt existence and non-existence, and serve to confine or circumscribe forms, so as to keep them from sliding or wandering out of the limits and conditions of matter.‡

34. In the twelfth place come the subjunctive instances, mentioned in the preceding aphorism, which we otherwise call instances of extremity, or termination, for these instances are not only useful, as being subjoined to fixed propositions, but also by themselves, in their own particular, as excellently shewing the true divisions or separation of nature, the measures of things, and how far nature may act and suffer; and again, they shew the transition of nature from one thing to another.

Of this kind are gold in weight, iron in hardness, the whale in bulk of animal body, the hound in point of scent, the explosion of gunpowder in sudden expansion, and the like.—Those things, also, which are last in the lowest degree, should be no less regarded than those that are first in the highest, as spirit of wine in weight or levity, silk in hardness or softness, the minute worms of the skin in animal bulk,‖ &c.

35. In the thirteenth place come instances of alliance, confederacy, or union, that is, such as mix and unite natures supposed to be heterogeneous, and noted and marked out for such by the divisions commonly received; for these instances shew, that the operations and effects attributed as peculiar to certain heterogeneous natures agree also to others, so as to prove that the heterogeneity which was founded in opinion is not true or essential, and nothing more than the modification of a common nature; whence these instances are of excellent use to rouse and elevate the understanding from differences to genuses or kinds, and to take off the masks and discover the counterfeit resemblances of things that occur and present themselves dressed, as it were, in concrete substances.

For example, let the nature sought be heat; in this case it seems a settled and authorized division, that there are three degrees of heat, viz. (1.) that of the heavenly bodies; (2.) that of animals; and (3.) that of fire; and that these heats (especially one of them compared with the other two) are in essence and species, or in their specific natures, perfectly different and heterogeneous, as the celestial and animal heats generate and cherish, but the heat of culinary fire corrupts and destroys: here, therefore, we have an instance of alliance in that common experiment, when a grown branch of a vine is brought within side of a

* See below, Aph. 34.

† Suppose the flame of spirit of wine, the *ignis fatuus*, or that harmless lambent flame, if real, said to have played about the heads of certain children.

‡ It deserves to be observed, how extremely careful and solicitous the author is to keep his forms from being any way notional or abstract things, which one might, at the first mentioning, be apt to suppose them, especially as men's ears have been accustomed to Aristotelian forms.

‖ These are correlative to the former, so that the two kinds limit nature both ways, or as well in the descending as in the ascending scale.

house, or into a room where a continual fire is kept, so as to ripen the grapes a month sooner than the grapes of the same vine are ripened without doors; whence it appears that fruit, even while it hangs upon the tree, may be ripened by culinary fire, though such ripening might seem to be a peculiar work of the sun.

And upon such an information as this, the understanding easily rouses, throws off the notion of essential heterogeneity, and inquires into those real differences to be found betwixt the heat of the sun and the heat of culinary fire, which cause their operation to be so dissimilar, though they partake of a common nature.

These differences will be found to be four, viz. (1.) that the heat of the sun, with respect to the heat of fire, is much more mild and gentle in degree; (2.) that it is of a much moister quality, especially as derived to us through the air; (3.) and principally, that it is very unequal, approaching one while increased in strength, and afterwards receding decreased, which is a thing of capital use to the generation of bodies; for it was justly observed by Aristotle, that a chief cause of the generations and corruptions upon the surface of the earth is the oblique motion of the sun through the zodiac, whence the heat of the sun, partly by the alternate changes of day and night, and partly by the succession of summer and winter, becomes wonderfully unequal; and yet this philosopher immediately after corrupts and spoils his own just position; for, rashly presuming to judge of nature, as his manner is, he very magisterially assigns the cause of generation to the approach of the sun, and the cause of corruption to its retiring, whereas both the access and recess of the sun give occasion to generation as well as to the corruption of things, not respectively, but as it were indifferently, for inequality of heat administers to their generation and corruption, but equality of heat to their conservation only.*

There is a fourth difference of very great moment, between the heat of the sun and of fire, viz. that the sun insinuates its operation for great lengths of time, whereas the operations of the fire, through the impatience of mankind, are hurried to a conclusion in short intervals; but, if any one were intent upon tempering the heat of fire, and reducing it to a moderate and gentle degree, which is easily practicable several ways, and would sometimes sprinkle and intermix a little moisture, and particularly if he would imitate the heat of the sun in point of inequality, and wait with patience somewhat longer than men usually do in chemical processes, he might get quite clear of that false notion of the heterogeneity of heat, and easily imitate, rival, or in some cases exceed, the operations of the sun by the means of culinary fire.†

We have a like instance of alliance in butterflies benumbed, and, as it were, become dead with cold; for these creatures are re-animated, or brought again to life, by means of a small warmth of fire, whence it easily appears, that fire can as well vivify animals as ripen vegetables. Thus, in the famous invention of Fracastorius, the metalline pan, strongly heated and applied near the head of a person in a dangerous fit of apoplexy, expands the animal spirits, compressed, and, as it

* See the Sylva Sylvarum, under the articles Preservation and Putrefaction.

† Here is a foundation laid for a kind of chemistry that seems to be very little known or practised.

were, suffocated by the humours and obstructions of the brain, and thus excites them to motion in the same manner as fire operates upon water or air, and at the same time consequently expands and quickens them.

Sometimes also eggs are hatched by the heat of a fire, which, in this respect perfectly resembles animal heat. These instances, therefore, with numerous instances of the like kind, render it unquestionable, that the heat of fire may in many cases be modified, so as to resemble and imitate the celestial and animal heats.

Again; let the nature sought be motion and rest. — Here it seems a settled division drawn from the depth of philosophy, that natural bodies either revolve, move in a straight line, or continue at rest, because motion is either without end, proceeding to an end, or stationary in the end. Now constant rotation seems proper to the heavenly bodies, station or rest to the terrestrial globe, and the other bodies called heavy and light, being out of their natural places, are carried strait upwards or downwards to the masses or congregations of similar bodies, those that are light towards the heavens, and those that are heavy towards the earth, and all this appears neat and plausible in discourse.

But we have an instance of alliance in some of the lower comets, which, though they descend below the celestial bodies, yet move irregularly through the various quarters of the heavens, as appears by experience and observation.

Another instance of alliance relating to this subject is the motion of air, which, between the tropics, where the circles of rotation are larger, seems itself to revolve from east to west.

The flux and reflux of the sea might be another instance of alliance, if the sea was observed to revolve, though but slowly and faintly, from east to west, yet so as to be driven back twice a day. Upon these suppositions, therefore, it is manifest that this motion of rotation does not terminate in the celestial bodies, but is communicated also to the air and ocean.*

Again: that property of ascending upwards, found in light bodies, labours under a defect; and to this purpose an instance of alliance may be taken from a bubble of water; for, if air be thrust under water, it hastily ascends to the surface, by the motion of impulse, as Democritus calls it, wherewith the descending water impels and raises the air upwards, and not by the striving or endeavour of the air itself, but when it comes to the surface of the water, the air is kept from ascending farther, by a small resistance it meets with in the water,† which will not presently yield to be discontinued or separated, so that the appetite of the air to rise upwards is exceedingly weak.‡

In like manner, let the nature sought be gravity. It is a received difference, that dense and solid bodies move towards the centre of the earth, but rare and light ones towards the heavens, as if, in each case, it were to their proper places;—but, as to these places, though the notion of them prevails in the schools, yet it is perfectly idle and

* See the Essay upon the ebbing and flowing of the sea.

† The water now throwing itself into a thin film or spherical bubble, to avoid a solution of continuity.

‡ Or, according to the late discoveries, none at all.—See Mr. Boyle's Works and Sir Isaac Newton's Principia, passim.

childish to imagine that place can have any effect; whence it is trifling in philosophers to assert, that, if the earth was perforated, heavy bodies, let fall in the perforation, would stop at the centre; for, in that case, a kind of nothing, or a mere mathematical point, would have a virtue and efficacy,* so as either to affect other bodies, or other bodies to affect it, whereas body is never affected but by body.

This appetite of ascent and descent is either in the structure of the body moved, or in a sympathy or consent with some other body; but, if any dense and solid body can be found, which does not move to the centre of the earth, this received difference will be falsified; and, if the opinion of Gilbert be admitted, that the magnetic virtue of the earth, whereby it attracts heavy bodies, extends not beyond its own sphere of activity, which always operates to a certain distance, and no farther, and this be verified by any instance, such an instance will be an instance of alliance upon this subject; but at present there is no certain and manifest instance thereof.†

What seems to come nearest to it, is the cataracts or spouts which are met with in sailing through the Atlantic Ocean towards either the East or West Indies; for, the quantity and bulk of water suddenly discharged by these cataracts appears so great, that they seem to be collections of water made before, and to have rested and remained in these places, and afterwards to be thrown down by some violent cause, rather than to fall by the natural motion of gravity. Whence we may conjecture, that a dense and compact body of a large bulk may remain at a great distance from the earth, pendulous, like the globe of the earth itself, without falling, till it be violently precipitated or thrown down.‡ But with regard hereto we affirm nothing for certain.

Only in this and numerous other cases it may easily appear how deficient we are in natural history, when, instead of verified and assured instances, we are often obliged to bring bare suppositions in the way of examples.‖

Again: let the nature sought be the reasoning faculty. A just distinction here seems made betwixt the human reason and the sagacity of brutes, yet there are some instances of actions which brutes perform, whereby they also seem to reason. Thus it is reported of a raven, that in a time of great drought, espying water in the hollow trunk of a tree, where the orifice was too small for her to enter, she continued to drop small stones therein, till the water rose high enough for her to drink. Whence the reason of the raven afterwards became proverbial.

Lastly, let the nature sought be vision. Here it seems to be an extremely just and exact distinction between light and colour, that light

* This is the general case of mathematical demonstrations applied to physics, where mere mental powers or forces are supposed, instead of those that really exist in nature. Hence great caution is required in the reading of mathematical writers upon physical subjects, lest ideal powers should be inadvertently introduced into matter, and let it be well considered and remembered, that what is mathematically just and true may be physically false and absurd.

† Sir Isaac Newton's doctrine and discoveries upon this head are now generally known; but, perhaps the physical cause of gravity still remains unassigned, so far, we mean, as it may be.

‡ See the account of spouts in the Philosophical Transactions.

‖ See Part II. Aph. 14.

is an original visible thing, affording the primary means of sight, and that colour is a secondary visible thing, not to be seen without light, whence it may seem no more than the image or modification of light, and yet there appear to be instances of alliance on both sides. — Thus, for example, in large quantities of snow, there seems to be a somewhat original lucid colour,* and in the flame of sulphur a light tending to colour.†

36. In the fourteenth place, come those we entitle Crucial Instances, deriving the word from the crosses set up where two roads meet, to point and mark out their separation again. We otherwise call them Decisive and Indicatory Instances, and, in some cases, Oraculous and Commanding Instances.

They are of this kind, that, when in the search of any nature, the understanding comes to an equilibrium, as it were, or stands suspended as to which of two or more natures the cause of the nature inquired after should be attributed or assigned, by reason of the frequent and common concurrence of several natures, then these Crucial Instances shew the true and inviolable association of one of these natures to the nature sought, and the uncertain and separable alliance of the other, whereby the question is decided, the former nature admitted for the cause and the other rejected.

These Instances, therefore, afford great light, and have a kind of over-ruling authority, so that the course of interpretation will sometimes terminate in them, or be finished by them. Sometimes, indeed, these Crucial Instances occur or are found among those already set down, but in general they are new, and expressly and purposely sought and applied, or, after due time and endeavours, discovered, not without great diligence and sagacity.

For example, let the nature sought be the tide of the sea, which happens twice in the day, and is six hours in coming in and six in going out, with a certain difference coinciding with the motion of the moon. Now, the cross-way of this subject lies as follows:

This reciprocal motion must of necessity happen either, 1, from the waters going forward and backward, like water moved in a bason, which, when it rises on one side, forsakes the other; or, 2, from the rising and falling down of the waters, like water that rises in boiling, and again subsides, but to which of these causes the ebbing and flowing of the sea should be assigned, is the doubt. If the former assertion be admitted, when the sea flows on one shore, it must necessarily ebb, about the same time, somewhere on the opposite shore, the inquiry, therefore, is thus brought to a point.

Now Acosta and some others have found, by diligent observations, that, on the coast of Florida, and the coasts of Spain and Africa, the sea flows and ebbs at the same times, not contrariwise; that, when it flows on the coast of Florida, it ebbs on the coasts of Spain and Africa; and yet, when carefully considered, the rising motion is not proved by this, and the progressive motion disproved, for it is possible that the waters may have a progressive motion, and yet overflow the opposite shores of the same channel at the same time; that is, if the

* For snow affords a considerable degree of light, by means whereof men travel by night in the northern regions.—See Mr. Boyle's History of Cold, passim.

† Viz. Blueness.

waters be protruded and driven from another quarter, which is the case of rivers ebbing and flowing on both shores at the same hours, though the motion here be clearly progressive, viz. the motion of the waters entering at the mouths of the rivers from the sea.

It may, therefore, happen, in like manner, that an immense collection of waters, rolling from the Indian Ocean, may be compelled and driven into the channel of the Atlantic, and thus overflow both shores at once; it must, therefore, be inquired, whether there is any other channel through which the waters may at the same times be discharged or taken off, and we find there is the South Sea at hand, a sea not less than the Atlantic, but rather wider, and of larger extent, which may suffice for this purpose.

And thus at length we come to the Crucial Instance in this subject, and it lies thus. If it be once certainly discovered, that, when it is flood on the opposite coasts of Florida and Spain in the Atlantic Ocean, it is also flood on the coast of Peru and along the coast of China in the South Sea, then the question is determined by this decisive instance, and the flux and reflux of sea we inquire after is shewn to happen by a progressive motion, for there is no other sea or place left where the return or reflux should be at the same time.—And this may most commodiously be known, by inquiring of the inhabitants of Panama and Lima, (where the Atlantic and Southern Oceans are separated by a small isthmus,) whether the sea flows on the contrary parts of that isthmus at the same time or not.

And this decision or determination seems certain, upon a supposition of the stability of the earth; but, if the earth revolve, there might thence possibly happen, from the different velocity between the rotary motion of the earth and the waters of the sea, a violent protrusion or compulsion of the waters in a heap upwards, so as to make the flux, and a falling of this heap downwards, after it could be kept up no longer, so as to make the reflux. But of this a separate inquiry should be made. Yet upon this supposition, it remains equally certain, that the sea of necessity ebbs in some places at the same time that it flows in others.

In like manner, let the nature sought be the latter of these two motions, viz. the motion of the sea spontaneously rising up and subsiding again. If it should happen, that, upon a careful examination, the progressive motion we speak of must be rejected, then the cross-way of this nature would lie thus, or go off in three different roads, for it must necessarily happen, that this motion, whereby the waters rise in flowing, and again fall back in ebbing, (without any additional waters joining them,) must proceed in one of these three ways, viz. 1. either this quantity of waters must spring or flow from the bowels of the earth, and again fall back into its receptacle; or, 2, the quantity of water is not enlarged, but only the same quantity extended or rarified, so as to possess a greater space or dimension and again contracted; or, 3, neither the quantity nor the bulk is enlarged, but the waters, remaining both of the same weight and density are raised by some attractive virtue, that draws them upwards, and calls them forth by consent, and then permits them to go again.

Therefore, dropping the two other motions, let the inquiry, for example, be reduced to the last, and the question will be, whether any such rising may happen by a consent, or attractive virtue. And here,

in the first place, it is manifest, that all the waters, as they lie collected in the cavity or bason of the sea, cannot be lifted up in one mass together, for want of something to succeed them at the bottom;* and, therefore, though they had any such appetite of raising themselves, yet it would be broken and prevented by the connection of things, or, as the common phrase is, by nature's abhorrence or dread of leaving a vacuum behind. It remains, therefore, that they must rise in one part, and consequently be diminished and give way in another, whence again it will follow, that the attractive virtue, as it cannot operate equally upon the whole, must operate strongly upon the middle, so as to raise the waters there; and, when they are thus raised, the shores will be successively left or forsaken by the waters.†

Thus, at length, we come to the Crucial Instance; for, if it be found, that in the ebbing of the sea, the surface of the water is more arched and spherical, while the waters rise up in the middle, and leave the sides, that is, the shores, shallow; and if in the flowing, the same surface shall become more flat and equal, viz. whilst the waters return to their former situation; then it may doubtless be admitted that the sea rises by attraction, or otherwise it should be totally rejected. And it were not difficult to try, by the sounding-line in streights, whether in the tide of ebb towards the middle of the sea, the sea be not deeper or higher than in the tide of flood; but, if this shall prove the case, it must be observed, that, contrary to the common opinion, the waters rise in the ebb and fall in the flood, so as in the latter only to cover and overflow the shores.

Again; let the nature sought be the spontaneous motion of rotation; and in particular, whether the diurnal motion, whereby the sun and stars rise and set to the sight, be a true motion of rotation in the heavenly bodies, or only apparent in them and real in the earth. The following may be a Crucial Instance in this inquiry: — if any motion, from east to west, is found in the ocean, though it be ever so languid and feeble, if the same motion be found somewhat quicker in the air, especially between the tropics, where, because of the larger circles, it will be more perceptible, if the same motion be found brisk and strong in the lower comets, if the same motion be found in the planets, so dispensed and proportioned, that the nearer it comes to the earth the slower it proves, and the farther off the quicker, but quickest of all in the sphere of the fixed stars, then doubtless the diurnal motion should be received for real in the heavens, and the motion of the earth be rejected, because it would then be manifest that the motion from east to west is perfectly cosmical,‡ and by consent of the universe, which, having the greatest velocity in the greatest heights of the heavens, gradually decreases, and at length terminates and comes to nothing, in what is immovable, viz. the earth.

On the other hand, let the nature inquired into be that other motion of rotation, famous among astronomers, and opposite and contrary to the diurnal motion, viz. the motion from west to east, which the astronomers attribute to the planets and sphere of the fixed stars, but

* Nothing, by supposition, could here succeed but atmospherical air.

† As is now generally allowed to be the case. — See Sir Isaac Newton's Theory of the Tides, explained by Dr. Halley in the Philosophical Transactions, No. 226.

‡ Viz. As belonging to the whole system of things.

Copernicus and his followers assign likewise to the earth; and let it be sought whether there is any such motion in nature, or whether it be only imaginary and supposed, for the readiness and convenience of calculation, and the sake of the beauty and regularity of a system, so as to make the celestial motions performed in perfect circles.

This motion is by no means proved true and real in the higher celestial bodies, neither from hence, that a planet does not, in its diurnal motion, return to the same fixed star again, nor from hence that the poles of the zodiac differ from the poles of the world, which are the two things whereon this motion is founded; for, the first phenomenon is well solved by the supposition of antecedence and dereliction, and the second by spiral lines; so that the inequality of the revolution, and the declination to the tropics, may be rather modifications of the same diurnal motion than contrary motions, or performed about different poles; and, if we may here, for once, side with the vulgar, and leave the fictions of astronomers and the schools, (who in many cases, without reason, offer violence to the senses, and rather affect obscurities,) we judge this motion to be to the sense such as we have above described it, from a model we once had purposely made of iron wire to represent it.

But it may be a crucial instance in this inquiry, if it shall be found, from any history worthy of credit, that there was a comet, which did not revolve in a manifest consent (though ever so irregularly) with the visible diurnal motion, but rather to the opposite part of the heavens; for then it will be free to judge that some such motion, contrary to the visible diurnal rotation, may exist in nature; but, if nothing of this kind can be found, such a motion should not be embraced, but recourse be had to other crucial instances about it.*

Again; suppose the nature sought was gravity, this will be the cross-road. Heavy and ponderous bodies must either have a natural tendency to the centre of the earth, on account of their proper mechanism, or else be attracted by the corporeal mass thereof, as by a collecion of bodies of the same nature, and so be carried to it by consent.

If the latter be the cause, it will follow, that the nearer all heavy bodies approach to the earth, the stronger and with the greater force and velocity they will tend to it; but, the farther they are from it, the weaker and the slower, and this to a certain distance; whence, if they were removed so far from the earth, as that the virtue thereof could not act upon them, they would remain pendulous, like the earth itself, without falling.†

And, with regard hereto, this may be a crucial instance. Take a clock that moves by weights, and another that moves by a steel spring, let them be exactly adjusted, that neither of them may go faster than the other; place the clock that goes with weights upon the top of some very high building, keep the other below; then carefully observe if the clock above move slower than usual, on account of the diminished virtue of its weight. Let the same experiment be made in the deepest mines, to shew whether such a clock will not move faster there, for the contrary reason; and, if the virtue of the weights shall be found diminished above and increased below the surface of the earth, let

* See the Author's specimen of animated astronomy.

† Compare this with Sir Isaac Newton's Laws of Motion.—See his Princip. in init.

the attraction of the terrestrial mass be received as the cause of weight or gravity.*

Again; let the nature sought be the verticity of the magnetic needle, and the cross-way will be this; the touch of the magnet must either of itself necessarily give iron the property of pointing north and south, or else only excite and prepare or fit the iron for the purpose, and the motion itself (as Gilbert conceives, and laboriously endeavours to prove) be given by the presence of the earth; and, therefore, the particulars which he has with much sagacity and industry discovered, amount to this, that an iron nail, which has long continued in the direction of north and south, may, by that mere continuance, receive a verticity without the touch of the magnet, as if the earth itself, though it operates weakly, by reason of its distance, (for the surface or external surface of the earth has no magnetic virtue, according to him,) should yet, in so great a length of time, supply the defect of the loadstone, excite the iron, and afterwards make it comply when thus excited. And again; that if ignited iron be quenched, pointing in the direction of north and south, it also receives a verticity without the magnetic touch, as if the parts of the iron put in motion by the ignition, and afterwards contracting themselves in the very instance of quenching, were more susceptive and sensible of the virtue rising from the earth than at another time, and thence become animated; but these particulars, though well observed, do not clearly prove his point.

This may be a crucial instance in the present case. Mark the poles of a terella, and place them east and west, then lay an untouched needle thereon, and let it remain for six or seven days. — The needle, no doubt, whilst it lies upon the magnet, will quit the poles of the world, and conform to those of the maget; and, therefore, as long as it remains thus, it points east and west; but, if the needle shall be found, when removed from the terella, or magnet, and placed upon its pin, immediately to turn north and south, or by degrees to move into that direction, then the earth's presence is to be admitted for the cause; but, if it turns as before, east and west, or loses its verticity, then that cause should be accounted doubtful, and farther inquiry be made.†

In like manner, let the subject of inquiry be the substance of the moon, to determine whether it be rare, flamy, or aerial, as many of the ancient philosophers conceived, or solid and dense, as Gilbert, with many of the moderns and some of the ancients, contend. The reasons of the latter opinion depend chiefly upon this, that the moon reflects the rays of the sun, and that light appears to be reflected by none but solid bodies; and, therefore, if there are any, those may be reckoned crucial instances, with regard to this subject, which demonstrate that reflection may be made by a rare body, as flame is, provided it be sufficiently thick.

And, doubtless, one cause of the twilight, among others, is the reflection of the sun's rays from the upper part of the air. We sometimes see the rays of the sun reflected in clear evenings from the edges of dewy clouds with a more resplendent brightness than that afforded by the body of the moon, and yet it is not certain that those clouds are

* See Sir Isaac Newton's Principia, passim.

† See the Sylva Sylvarum, under the article Magnetism.

collected into a dense body of water. So likewise we see that the dark air behind a window by night reflects the light of a candle as well as a dense body.

Experiment also should be made of transmitting the sun's rays through a hole, upon a dusky or blue flame; for, the free, open, and uncontined rays of the sun, falling upon obscure flames, seem to deaden them and make them appear rather like white fumes than flames.* And these are instances that occur for the present, to shew the nature and use of the crucial instances, with regard to this subject, though, doubtless, better may be found for the purpose; but, let it always be observed, that a reflection from flame is not to be expected, unless the flame be of some depth, thickness, or body, for, otherwise, it inclines to transparency. But this is to be held certain, that light in a uniform substance is always either received and transmitted or reflected.†

Again; let the nature sought be projectile motion, as the motion of a dart, an arrow, a bullet, &c. through the air. — This motion the schools, according to their custom, have slightly passed over, esteeming it sufficient to distinguish it by name of violent motion from that they call natural; and, for the first impulse, satisfying themselves with this, that two bodies cannot be in the same place, otherwise a penetration of dimensions would ensue, without at all regarding the continued progress of this motion.

The cross-way here lies thus:—this motion is either caused by the air propelling and gathering itself behind the projectile, as the water does behind a ship, and the winds behind the chaff which they blow away, &c. or else by the parts of the body not sustaining the impulse, but urging forward to relax themselves by succession from the impelling force. Fracastorius, and nearly all those who have made any subtile inquiry into this motion, take the first path, nor can it be questioned but the air has some share herein, though, doubtless, the other motion is a true one, as appears from numerous experiments.

But, among the rest, this may be a crucial instance to the purpose, that a piece of stubborn iron plate, wire, a quill, or the like, being bent in the middle by the fingers, will, when let go, spontaneously fly back. Now, it is plain that this motion cannot be attributed to the air collecting itself behind the body, because the origin of the motion is in the middle of the plate, wire, or quill, and not in the extremities or ends.‡

Again; let the nature sought be the rapid and powerful expansion of gunpowder into flame, whereby such vast masses of building are overturned, and such great weights thrown to a considerable distance, as we see in the springing of mines, the firing of mortars, &c. — The double road here lies thus:—This motion is either excited by the mere appetite of the body to dilate itself after it is set on fire, or by a mixed appetite of the crude spirit of the nitre, which, with great rapidity, avoids and flies from fire, and violently bursts out from the midst thereof, as from a prison. The schools and the vulgar opinion here consider only the former appetite, for men have thought they philosophised

* See Sir Isaac Newton's Optics, passim. and Dr. Hook's Lectures of Light.

† See Mr. Boyle of Colours, and Sir Isaac Newton's Optics.

‡ See the Essay upon Violent and Projectile Motion.

notably in asserting flame to be endowed, by the form of the element, with a necessary quality of possessing a larger space, than the same body possessed when it had the form of gunpowder, and that this motion must thence ensue.

But here they observe not, that, though this be true, upon supposition the flame is ready generated, yet the generation of flame may be hindered by a mass of matter able to suppress and suffocate it, so that the thing may not be reduced to the necessity they speak of. Indeed, as to the necessity of the expansion, and the consequent explosion, or discharge of the bullet, or obstructing body, when the flame is generated, they judge rightly; but this necessity is plainly avoided, if the solid body suppress or prevent the flame, before it is generated. And we see that flame, especially in its first generation, is soft and gentle, requiring a cavity wherein to play and exert itself; whence such a violence cannot be attributed to flame of itself.

Without doubt, the generation of this flatulent flame, or, as it were, fiery wind, arises from a conflict of two bodies, that have very different natures; the one being highly inflammable, which is the nature powerful in sulphur; the other highly impatient of flame, which is the case in the crude spirit of the nitre, whence a wonderful conflict arises: the sulphur immediately catching all the flame it is capable of, and the spirit of nitre bursting forth with all its violence, at the same time dilating itself, as air, water, and all crude bodies do, when affected by heat, and whilst it breaks forth, and flies off every way, it blows up the flame of the sulphur, as it were with internal bellows; the willow coal, in the composition, serving for little more than to incorporate and commodiously unite the sulphur and salt-petre together.*

But the crucial instances upon this subject might be of two kinds; the one with regard to those bodies which are most inflammable, as sulphur, camphire, naphtha, &c. with their mixtures; and which, if not otherwise hindered, take flame more easily than gunpowder; whence it is plain, that the appetite of inflammability does not of itself produce this stupendous effect.

The other kind is of those bodies which resist and repel flame, as all salts do; for we find, when these are thrown into the fire, a watery spirit breaks out, with a cracking noise, before they take flame, which the more stubborn kind of leaves† do also in a gentler manner; their aqueous part bursting forth before their oily part takes flame. But this appears more eminently in quicksilver, which is not improperly called a fossil, or metallic water; for quicksilver, without taking flame, almost rivals the force of gunpowder, by bare eruption and simple expansion,‡ and being mixed with gunpowder is said to increase the strength thereof.‖

Lastly, let the subject of inquiry be the transitory nature of flame, and its momentary extinction; for the flamy nature does not with us

* See the Essay upon the Cause of the Motion of Explosion in guns and gunpowder.

† Such, in particular, as ivy, bays, &c.

‡ That is, supposing the quicksilver close confined and heated, as it might be, to shew the thing, in a gun-barrel, with the touch-hole stopped, and the charge hard rammed down with paper, &c.

‖ Consider of the *Aurum Fulminans*; the common *Pulvis Fulminans*; the ways of making the *Mercurius Fulminans*; and the means of increasing the strength of gunpowder, by salt of tartar, precipitated metals, &c.

appear permanent and at a stay, but to be momentarily generated, and presently after extinguished again. It is manifest, that in the flame here supposed to be continued and durable, the duration is not of the same individual flame, but happens by a succession of new flame regularly generated, without continuing numerically the same, as easily appears hence, that if the fuel or aliment be taken away, the flame presently goes out.

The two ways in this subject lie thus:—the momentaneous nature proceeds either from a remission of the cause that first produced it, as in light, sounds, and those called violent motions; or else from this, that flame, in its own nature, cannot subsist here below without suffering and being destroyed by the contrary natures around it.

This, therefore, may be a crucial instance in the case. We see, in great conflagrations, that flames will ascend to a considerable height; for the wider the basis of the flame, the higher its vertex rises; and therefore extinction appears to begin about the sides, where the flame is compressed and opposed by the air; but the inner parts of the flame untouched by the air, and every where surrounded by other flame, remain numerically the same, without being extinguished, till they come to be gradually squeezed by the air diffused about the sides; and therefore all flame is pyramidal, or large in its basis, about the fuel, but sharp at the vertex, the air being its antagonist, and not supplying fuel. But the smoke, which is narrower about the basis, dilates itself in ascending, and becomes like an inverted pyramid, because the air receives smoke, but compresses or squeezes flame. And let no one fondly imagine, that flame is air set on fire, for flame and air appear perfectly heterogeneous.*

We might have a more accurate crucial instance to this purpose, if the things could be manifested by flames of different colours. Take, therefore, a small metalline dish, and fix therein a small wax-taper lighted; set the dish in a wider vessel, and pour spirit of wine round it in a moderate quantity, so as not to touch the upper rim or edge of the dish; fire the spirit of wine, and this will exhibit a bluish flame; but the wax-taper one that is yellower. And now let it be observed, whether the flame of the taper remains pyramidal, which may easily be distinguished through the blue-coloured flame of the spirit of wine, (for flames do not presently mix as aqueous liquors do,) or whether it tends not to a spherical figure, as there is nothing present to destroy or compress it. And if the latter prove to be the case, it may be held certain, that flame remains numerically the same, so long as it is surrounded by other flame, without feeling the hostile effect of the air.†

And so much for crucial instances, upon which we have been the fuller, that men may gradually learn and accustom themselves to judge of nature by instances of the cross, and experiments of light, and not by probable reasonings ‡

* Dr. Hook's Lectures of Light, passim.

† This is a subtile experiment, and of great moment.

‡ Which are endless, and lead to no solid determinations. And, by this time, if the Reader has been tolerably attentive and diligent, he will have a clear perception of the superior excellence and use of this Doctrine of Prerogative Instances, and be enabled, in some tolerable degree, to prosecute Inquiries by their means, in order to the full investigation and discovery of the forms of things.

37. In the fifteenth place, among prerogative instances, come the instances of divorce, which indicate the separation of such natures as frequently meet or come together. These differ from the subjunctive kind, or instances subjoined to accompanying instances;* because those indicate the separation of a nature from a concrete wherein it familiarly appears, but these the separations of one nature from another. These also differ from crucial instances, as determining nothing, but only admonishing us of the separability of one nature from another.

Their use is to discover false forms, and to dissipate superficial notions and speculations arising from obvious things, so that they add, as it were, ballast to the understanding.

For example, let the subject of inquiry be those four natures which Telesius calls chamber-fellows, as if they came out of the same room, viz. heat, light, rarity, and mobility, or aptness to motion. Now, though these natures seem to be nearly related, yet there are many instances of divorce found among them: for, 1, the air is rare, and ready to motion, but not hot or shining; 2, the moon is lucid, without heat; 3, water is hot, without light; 4, the motion of the magnetic needle in the compass is swift and nimble, yet that needle is a cold, dense, and opake, body: and there are many other examples of this kind.†

Again, let the subject of inquiry be the corporeal nature and natural action; for natural action seems to be no where found, but as it subsists in some body or other; and yet with regard hereto, there may perhaps be instances of divorce, as in the magnetic action suppose, where iron is attracted to the loadstone, and heavy bodies to the globe of the earth; to which may likewise be added some other operations performed at a distance. For this kind of action is both performed in time by successive moments, or not instantaneously, and in place by degrees, and through space; whence, consequently, there is some moment of time, and some distance of place, wherein this virtue, or action, must be in the middle, between the two bodies that cause the motion.

The consideration, therefore, amounts to this, whether the bodies, which are the boundaries of the motion, dispose or alter the intermediate bodies, so as that by succession, and real contact, the virtue may slide from point to point, and in the mean time exist in the intermediate body, or whether there be nothing of this kind, besides the bodies, the virtue, and the space or distance.

Now, in the case of rays of light, sounds, heat, and some other things operating at a distance, it is probable, that the intermediate bodies are affected and altered, the rather because a qualified medium is required to convey such operations. But the magnetic or attractive virtue passes through all mediums indifferently, for it is not hindered by any one. But if this virtue or action is independent on the intermediate body, it follows that it is a natural power or action, subsisting for a time in some place without a body, since it neither subsists in the terminating nor intermediate bodies. And hence the magnetic action may be an instance of divorce, in the subject of corporeal and natural action.

To this may be added, by way of corollary, the following considerable discovery, viz. that by philosophizing, even according to sense, a

* See above, Aph. 33 and 34.

† By comparing this with Aph. 4, of the present part, the use of these Instances, in discovering false forms, will sufficiently appear.

proof may be had of the existence of separated and incorporeal beings and substances; for if natural virtues and actions flowing from a body may subsist without a body for some time in space or place, it is possible that such virtues or actions may proceed originally from an incorporeal substance: for a corporeal nature seems no less required to support and convey, than to excite and generate, a natural action.

38. Now follow five orders of instances, which, by one general expression, we term instances of light, or instances of primary and original information, being such as administer to the senses; for, as all interpretation of nature begins from sense, and, from the perception of the senses, leads in a strait, continued, and guarded, path, to the perceptions of the understanding, which are true notions and axioms, it necessarily follows, that the more copious and exact the representations or informations of the sense shall be, the more easy and successful every thing else will prove.*

The first of these five orders of instances of light are such as strengthen, enlarge, and rectify, the immediate actions of the senses. The second are such as bring down insensible things to sensible. The third are such as indicate the continued processes or series of those things and motions, which remain generally unobserved in their end or period. The fourth substitute somewhat to the sense in those cases that leave it perfectly destitute. And the fifth raise the attention and edge of the sense, and at the same time limit the subtilty of things. To each of these five kinds we shall speak in their order.†

39. In the sixteenth place, we therefore range instances of entrance, or instances of the portal; by which we mean those that assist the immediate actions of the senses. But of all the senses the sight has the chief prerogative in point of information, and, therefore, helps are principally to be sought for the improvement of the sight. And these helps may appear of three kinds, viz. (1.) such as enable us to see things that are otherwise invisible; (2.) such as enable us to see things at a greater distance; and (3.) such as cause to see more exactly and distinctly.

(1.) Of the first kind are the newly invented microscopes, which shew the latent and otherwise invisible small parts of bodies, and their secret textures and motions, remarkably increased in the magnitude of the object; by means whereof, the exact figure and lineaments of the body of the minutest creatures, such as flies, fleas, mites, &c. as also colours and motions, before invisible, may be seen in a delightful and surprising manner.‡

And here, as is usual in new and strange discoveries, a superstitious observation has crept into the minds of men, as if this invention of microscopes did honour to the works of nature, but dishonour to the works of art, by shewing the one much finer than the other;‖ whereas the truth

* This paragraph being fundamental and leading, requires to be well understood and remembered; the business of raising Axioms depending upon it.

† See below, Aph. 39, 48.

‡ See Dr. Hook's Micographia, Dr. Power's Experiments, and Leuwenhoeck's Observations.

‖ Because some microscopical observers, upon viewing the point of a needle, or other the finest works of the hand, and comparing these with the hairs, or downy feathers of animals, &c. find the former to be coarse, rough, and unfinished, in comparison of the latter, and thence fondly extol the excellence of the works of nature above those of art.

only is, that natural textures are much more subtile than artificial ones. For these microscopes are only of use in the case of minute objects; so that if Democritus had seen them, he would perhaps have rejoiced, and imagined a way was now discovered for rendering the atoms visible, which he pronounced to be no object of sight.

But the unsuitableness and insufficiency of these microscopes, except for very minute bodies, (and then only when such minute bodies are not parts of larger,) destroys the use of the invention; which, if it could be extended to large bodies, or to small particles of large bodies, in the piece, after the manner of making a piece of fine lawn appear like a net, so as that, by this means, the latent small particles and inequalities of gems, liquors, urine, blood, wounds, and many other things, might be distinguished, great conveniencies would doubtless arise from the discovery.*

Of the second kinds are telescopes, which were nobly attempted and discovered by Galilæo; by means whereof, as by boats or little ships of intelligence, a nearer commerce may be opened and carried on with the celestial bodies. For, by the help of these glasses, 1. the milky way appears to be a knot or cluster of little stars, perfectly separate and distinct, of which the ancients had but a bare suspicion. 2. And again, by their means it should seem, that the planetary regions contain more stars besides the direct planets,† and that the Heavens may begin to be spangled with stars, at a great distance below the sphere of the fixed stars, though with such only as are invisible, without the help of telescopes. And again, 3. by their assistance we may behold the motion of those small stars, or satellites, about the planet Jupiter; whence it may be conjectured, that the revolutions of the stars have regard to several centres.‡ 4. Again, by their means, the luminous and opaque inequalities are more distinctly perceived and ascertained in the moon, whence a geographical description might be made thereof.|| 5. And, lastly, by means of these glasses, spots in the sun, and other things of that kind, appear to the sight; all which are, doubtless, noble discoveries, so far as they may be safely depended upon for real. But, indeed, I the rather incline to suspect them, because experience seems wholly to rest in these few particulars, without discovering, by the same means, numerous others, equally worthy of search and inquiry.§

(3.) Of the third kind, are those staffs, astrolabes, and the like instruments, for measuring distances, which not only enlarge and improve the sight, but also rectify and direct it.** And as for the instances that assist both this and the other senses, in their immediate and individual actions, without affording any information beyond that assistance, we here omit them, as making nothing to the present purpose.

* But no considerable improvement of this kind has hitherto appeared, the greatest magnifiers being the smallest globules, or spheres of glass. See Sir Isaac Newton's Optics; Dr. Hook's Lectures of Light and Micographia; and the Elements of Dioptrics in Wolfius's Elementa Matheseos Universæ, Tom. II. p. 284.

† Viz. The Satellites of Jupiter, &c.

‡ As in Sir Isaac Newton's System they are found to have.

|| As is done by Hevelius, in his Selenographia.

§ See the Author's Essay towards a Philosophical History of the Heavens, and Sir Isaac Newton's Planetary System, in the Third Book of his Principia.

** The instruments of this kind are numerous, and their descriptions frequent in the writings upon Instruments, Levelling, Practical Mathematics, Navigation, &c. See these writers enumerated at the end of the second Tome of Wolfius's Elementa Matheseos Universæ.

And hence we do not mention the contrivances for correcting any particular defect of the sight, because these afford no farther information.

40. In the seventeenth place, among prerogative instances come those we call summoning or citing instances, borrowing the term from the bar, where persons are summoned, or cited to appear, who did not appear before; and, accordingly, these instances bring down insensible things to such as are sensible.

Things escape the senses, either, 1. through the distance of the object, as to place; 2. through the interception of interposing bodies; 3. because the object is unfit to make an impression upon the sense; 4. because the object is not sufficient, in quantity, to strike the sense; 5. because the time is not proportionate, so as to actuate the sense; 6. because the percussion of the object is not endured by the sense; 7. and lastly, because an object before detained and possessed the sense, so as to leave no room for a new motion.

And these several ways chiefly regard vision in the first place, and touch in the second; for these two senses give information at large, and of common objects, but the three others give little information, besides what is immediate, and relates to their corresponding objects.

In the first way there is no reducing the object to sense, except, when things cannot be perceived by reason of the distance, others are used, or substituted for them, which may excite and strike the senses at a great distance, as in giving signals by the lighting up of fires, the ringing of bells, &c.

In the second way, a reduction is made, when such things as lie concealed within, by reason of the interposition of bodies that cannot be commodiously opened, are brought to the senses, by means of those things which are upon the surface, or flow from within; as the state of the human body is known by the pulse, or urine; and the like.

But the reduction in the third and fourth ways regard numerous particulars, and ought on all sides to be collected in inquiries. Thus, for example, it appears that the air, the spirit, and things of that kind, which in their whole substance prove light and subtile, can neither be perceived nor touched, whence in the inquiry after such bodies, we must necessarily use reductions.

Suppose, therefore, the subject of inquiry were the action and motion of the spirit included in tangible bodies; for every tangible body, with us, contains an invisible and untangible spirit, over which the body is drawn like a garment. And hence arise those three powerful springs, and that wonderful process, of the spirit in tangible bodies. For, 1. the spirit being discharged out of a tangible body, the body contracts and dries; 2. whilst detained, it makes the body tender, supple, and soft; and, 3. being neither totally discharged, nor totally held in, it informs, fashions, assimilates, ejects, organizes, &c. And all these are rendered sensible by visible effects.*

For in every tangible, inanimate body, the included spirit first multiplies itself, and, as it were, feeds upon those tangible parts which are most disposed and prepared for that purpose; and thus digests, works, and converts, them into spirit, till at last they fly off together.

And this business of making and multiplying the spirit is brought down to the sense by the diminution of the weight of the body; for, in

* This requires to be well understood, and is explained in what follows; but for farther information, see the Sylva Sylvarum, and History of Life and Death.

all drying, part of the quantity goes off, which is not only the spirit that pre-existed in the body, but a part of the body itself, that was before tangible, and is now newly converted into spirit, for the pure spirit has no gravity.*

The emission, or exit, of this spirit is rendered sensible by the rusting of metals, and other corruptions and putrefactions of that kind, which stop before they come to the rudiments of life; for, in the more compact bodies, the spirit finds no pores and passages through which to escape; and is therefore obliged to protrude the tangible parts, and drive them before it, so as to make them issue at the same time; whence proceeds rust, and the like.†

But the contraction of the tangible parts, after some of the spirit is discharged, upon which dryness ensues, is made sensible by the increased hardness of the body, but much more by the subsequent cracking or splitting of the body, and the contracting, wrinkling, and overwrapping of the parts. Thus the parts of wood crack, or split asunder, and are contracted; skins wrinkle, and if the spirit be suddenly forced out by the heat of fire, they shrink so fast as to curl and roll themselves up, &c.

On the other hand, where the spirit is detained, and yet dilated and excited by heat, or something analogous thereto, (as happens in the more solid or tenacious bodies,) then the body is either softened, as in the case of ignited iron, or flows, as in melted metals, or liquifies, as in dissolved rosin, wax, &c.; therefore these contrary operations of heat, hardening some bodies, and liquifying others, are easily reconciled; because in the first case the spirit is driven out, but agitated and detained in the second; the latter being the proper action of heat and spirit, and the former the action of the tangible parts, succeeding upon the emission of the spirit.

But where the spirit is neither quite detained, nor quite discharged, but only attempts and tries to force its prison, and readily meets with such tangible parts as will obey, and yield to its motions, so that wherever the spirit leads they follow it, then it is that an organical body is formed, with its distinct parts or limbs, and that all the vital actions ensue, as well in animals as vegetables.

And these operations are principally brought down to the sense, by diligently observing the first beginnings, rudiments, strugglings, or tendencies towards life, in the little creatures bred from putrefaction, as in the eggs of ants, in worms, flies, frogs after rain, &c. For here are required to vivification, both gentleness of heat, and tenacity of body, that the spirit may neither break forth too hastily, nor be too much confined, by the stubbornness of the parts, but rather be able to mould and fashion them, like wax.

* In the air at least, as being specifically lighter than air. But whether any thing farther be here meant by spirit having no gravity, will best appear from the Author's History of Life and Death, the History of Condensation and Rarifaction, &c.

† Rust is now usually supposed to be occasioned by the external air, or something contained therein, that preys upon and in part dissolves the external surface of the metal. Here then is what the Author calls a Cross-Road, that requires a Crucial Instance. Let trial, therefore, be made, whether iron will rust in an exhausted receiver. And, by the way, let not the examples here produced, as illustrations of the doctrine of Prerogative Instances, be supposed any way intended as decisive, their designs being rather logical than philosophical, so as to shewthe way of prosecuting inquiries, and not themselves to serve as inquiries.

Again, that noble difference of the spirit, which has regard to so many things, is brought and submitted, as it were, to view, by numerous summoning or reductory instances.* This difference we mean is that of the truncate spirit, the spirit simply ramous, and the spirit both ramous and cellulous: the first whereof is the spirit of all inanimate bodies, the second the spirit of vegetables, and the third the spirit of animals.†

In like manner, it appears, that the more subtile textures and structures of things (though visible and tangible in their entire bodies) are neither seen nor felt; and, therefore, in these also the business of information proceeds by reduction. But the most radical and primary difference of structures is taken from the greater or less quantity of matter contained in the same space or dimension; for the other structures depending upon the dissimilarity of the parts contained in the same body, and their situations, are but secondary, in respect to those.

Thus, let the subject of inquiry be the expansion or contraction of matter in bodies respectively, to discover what quantity of matter fills what quantity of space in each. Now, there is nothing truer in nature than those twin propositions, that nothing can never make something, and that something can never be reduced to nothing; but the entire quantity, or total sum of matter in the universe, still remains the same, without increase or diminution. It is also as certain, that a greater or less quantity of matter is contained under the same space or dimensions, according to the difference of bodies.‡ Thus water contains more matter than air; whence to assert, that an equal bulk of water is convertible into an equal bulk of air, is to assert, that something is reducible to nothing; as, on the other hand, to assert, that a certain bulk of air may be turned into an equal bulk of water, is the same as to assert, that something may be made out of nothing. And from this greater or less quantity of matter, those notions of density and rarity, which are variously and promiscuously received, may be corrected, or new ones justly derived.

It must be likewise allowed as certain, that this greater or less quantity of matter we speak of, contained in bodies, may, by comparison, be brought to calculation; and the exact, or nearly exact, proportion determined. Thus, for example, we should not greatly differ from the truth to say, that a given bulk of gold contained about two-and-twenty times as much matter as an equal bulk of spirit of wine; or that a bulk of spirit of wine, equal to the bulk of gold, must possess about two-and-twenty times as much space as the gold.‖

But the density of matter, and the proportions thereof, are made sensible by weight, for weight corresponds to quantity of matter, with regard to the tangible parts of bodies; but spirit, and its quantity of matter, is not cognizable by the balance, because it rather diminishes than increases weight. And with this view, we have made a table, to shew the specific gravities, or weights and bulks, of all the metals, the principal stones, woods, liquors, oils, and many other bodies, as well

* See the Sylva Sylvarum.

† See the History of Life and Death.

‡ On this is founded the use of the Hydrostatical Balance. See the Author's History of Condensation and Rarifaction.

‖ See the Author's Table of the Specific Gravities of Bodies.

natural as artificial. And such a table we judge to be of infinite use, as well to procure the light of information, as to serve for a rule in practice, and again to discover many particulars, that would have been absolutely unexpected.

It is no small advantage of this table to demonstrate, that all the variety found in the numerous tangible bodies known to us (which are compact, and neither spongy, hollow, nor in great part filled with air) exceeds not the proportion of twenty-two to one.* So finite a thing is nature, at least that part thereof whose use principally regards ourselves.†

We also thought it worth trying to discover the proportions of untangible or pneumatic bodies, with respect to such as are tangible, for which purpose we took an ounce vial, choosing it small that the following evaporation might be performed with the less heat. This vial we filled almost to the neck, with such spirit of wine as we observed by the table, mentioned above, to be specifically lighter, or to contain less matter, under the same dimension, than all other tangible bodies that are close and compact. Then we exactly marked down the weight of the spirit, and the vial together. After this, we took a bladder, containing about a quart, and squeezed all the air out, as near as possible, till the sides of the bladder collapsed, and became contiguous, having first gently oiled it, to render it the closer or tighter, by filling up the pores, if there were any. This bladder we strongly tied with a wax thread about the neck of the vial, putting the mouth of the vial into the neck of the bladder, then setting the vial upon a chafing-dish of warm embers, the vapour of the spirit, dilated by the heat, and thus rendered pneumatical, gradually distended or swelled out the bladder every way, like a sail. Then we immediately removed the glass from the fire, and placed it upon a carpet, to prevent its breaking by the cold, and now we directly made a hole in the upper part of the bladder, lest the vapour, as the heat diminished, should fall back, or condense into liquor, and disturb the calculation. Then taking away the bladder, we weighed the remaining spirit of wine, and thence computed how much was wasted in vapour; and, by comparison, calculated how much space the body possessed in the form of spirit of wine in the vial; and again, how much it possessed when rendered pneumatical in the bladder; it plainly appeared, that the body, so converted and changed, acquired a degree of extension a hundred times greater than it had before.

In like manner, let the nature sought be heat or cold, so weak in degree as to be imperceptible. These are brought to the sense by means of a weather-glass, such as we have above described,‡ wherein heat expands and cold contracts the air. Neither is this expansion and contraction of the air perceptible by sight; but the air, when expanded, depresses water, and when contracted raises it up; and thus alone it is that the thing becomes visible and sensible, and not otherwise.

In like manner, let the subject of inquiry be the mixture of bodies, to determine what they contain that is aqueous, oleaginous, spirituous, saline, earthy, &c. or, in particular, how much butter is contained in milk, how much curd, how much whey, &c. All these things are re-

* Suppose the difference in specific gravity between gold and spirit of wine.

† Viz. The tangible part.

‡ Aph. 13.

duced and brought down to the senses by artificial and skilful preparations, exhibited in the form of tangible bodies;* but the nature of the spirit in them, though not immediately perceived, is discovered by the various motions and endeavours of tangible bodies, in the act and process of their separation, as also by the acrimony, corrosiveness, different colours, smells, and tastes, of the same bodies after separation.

And, with regard hereto, men have bestowed great pains upon distillations and artificial separations, but not with much better success than in the other experiments hitherto practised, as having proceeded altogether by feeling out their way in blind roads, or with more labour than understanding; and, what is worse, without imitating, copying, or rivalling, nature; but, by their violent heats and over-powerful operations, destroying all the subtilty of structure, in which the secret virtues and relations of things are principally seated.†

Nor have men, as we elsewhere observed,‡ hitherto taken notice, with regard to this kind of separations, that numerous qualities in the torturing of bodies, as well by fire as otherwise, proceed from the fire itself and the matters employed in the separation, which qualities were not before in the composition, whence strange fallacies have arisen.—Thus all the vapour which water emits by fire is not the vapour or air before existing in the body of the water, but in great measure produced by the dilation of the water, through the interposition of the heat of the fire.

So likewise, in general, all exquisite trials and examinations of bodies, whether natural or artificial, made to distinguish the genuine from the adulterate and the better from the worse, should be referred to this head, as these also make what is insensible to appear sensible, and therefore are, with great care, to be collected from all quarters.‖

As to the fifth way of concealment from the senses, it is manifest that the action of sense is performed in motion, and motion in time, whence, if the motion of any body be either so slow or so swift as not to be proportioned to the moments wherein the act of sensation is performed, the object will not be perceived, as we find in the motion of the hand of a clock, and the motion of a bullet discharged from a gun.

But the motion, which is not perceived, through its slowness, is easily and commonly reduced to sense by the result or amount of the motion; but that which is imperceptible through its velocity is not hitherto well measured, yet the inquiry of nature demands that this should be done in some cases.§

In the sixth case, where the sense is hindered by the too great power of the object, reduction is made either, 1, by removing the object farther from the organ of sense; or, 2, taking off from its force by the

* As in all those called Chemical Analyses, or Resolutions.

† Hence there are few genuine separations to be found in the common chemistry, even as practised by the best hands. — See the Sylva Sylvarum, under the article Gold, &c.

‡ See Part II. Aph. 7, and the Sylva Sylvarum.

‖ See Mr. Boyle's Medicina Hydrostatica, and the De Augment. Scientiar.

§ Thus the motion of sounds, and even of light, which seems the swiftest motion of all, is now reduced to calculation.—See the Author's History of Sounds, in the Sylva Sylvarum, and Sir Isaac Newton's Optics and Principia, passim.

interposition of such a medium as may weaken but not annihilate it; or, 3, by admitting or receiving the reflexion of the object, where the direct force of it is too strong, as by receiving the reflexion of the sun in a bason of water.

The seventh case of concealment from the senses (viz. that wherein the sense is so full charged with the object as to leave no room for the admission of a new one) is almost wholly confined to the sense of smelling, and odours, and does not considerably regard the subject in hand; so that thus much may suffice for the business of reducing insensible things to such as are sensible. — Sometimes also reduction is made, not to the sense of man but to the sense of other creatures, whose sensations, in some particulars, exceed those of men, as the sensation of a hound in some kinds of smell, and the sensation of a cat, an owl, &c. which see things in the night by the latent light of the air, which is not externally illuminated; for, Telesius has justly observed, that there is a certain original light in the air itself, though small, faint, and generally unserviceable with regard to the eyes of men and many other creatures; because the animals to whose sense this light is proportioned can see by night, which it is not so probable they should do without light, or by an internal light of their own.*

It must here be observed, that we treat only of the failures and insufficiencies of the senses and the remedies thereof, for the deceptions of the senses should be referred to the particular inquiries of sense and sensibility,† excepting only that grand fallacy of the senses in making the measure and rule of things correspond to man and not to the universe, which is an error that cannot be corrected but by reason and universal philosophy.‡

41. Among our prerogative instances, we assign the eighteenth place to journeying instances, which we also term instances of the road, and sometimes jointed instances, that is, such as indicate the motions of nature, gradually continued or connected. But the instances of this kind rather escape the observation than the sense; and, indeed, the negligence of men is here surprizing, for they contemplate nature only by fits and starts, or periodically, and then too it is after bodies are complete and finished, and not in their process, or whilst the operation is in hand. — But if any man desired to consider and examine the contrivances and industry of a certain artificer, he would not be content to view only the rude materials of the workman, and then immediately the finished work, but covet to be present whilst the artist prosecutes his labour and exercises his skill; and the like course should be taken in the works of nature.

For example, if any one would inquire into the vegetation of plants, he should have an eye from the first sowing of the seed, and examine it almost every day, by taking or plucking up a seed after it had remained for one, two, or three days in the ground; to observe with diligence, (1.) when, in what manner, the seed begins to swell, grow plump, and be filled, or become turgid, as it were, with spirit; (2.) next, how it bursts the skin, and strikes its fibres with some tendency upwards, unless the earth be very stubborn: (3.) how it shoots its fibres

* See the Author's Table of Inquiry for the History of Light and Splendor.

† See De Augment. Scientiar. and the Sylva Sylvarum.

‡ See Part I. Aph. 42, &c.

in part to constitute roots downwards, in part to form stems upwards, and sometimes creeping sideways, if it there find the earth more open, pervious, and yielding, with many particulars of the same kind.*

And the like should be done as to eggs during their hatching, where the whole process of vivification and organization might be easily viewed, and what becomes of the yolk, what of the white,† &c. Understand the same from creatures bred from putrefaction; for, as to perfect terrestrial animals, it is somewhat inhumane to inquire into them, by cutting the fœtus out of the uterus, unless when opportunity offers by death, abortions, the fortune of the chace, &c. A watch, therefore, is by all means to be kept upon nature, as she is better discovered by night than by day,‡ for these contemplations and inquiries may be called nocturnal, by reason of the smallness, or durability, or slow-burning, of the watch-light here set up.

The same is also to be attempted in animate bodies; and this we have endeavored after by observing the ways wherein liquors open themselves, for water opens one way, wine another, vinegar another, verjuice another, and milk, oil, &c. with a still greater difference, as may easily be perceived by boiling them over a soft fire in a glass vessel.‖ But these things are here touched lightly; the place for treating them more exactly and fully being when we come to inquire into the latent process of things;§ for it must be all along remembered, that we do not at present treat themselves, but barely produce examples.

42. In the nineteenth place come supplimental instances, or instances of substitution, which we also call instances of refuge; that is, such as afford information where the senses perfectly fail us, so that we have recourse to them when the proper instances cannot be had.—This substitution is procured two ways, viz. either by approximation or by analogy.

For example, there is no medium found that can possibly exclude the operation of the loadstone in moving iron, not gold, not silver, stone, glass, wood, water, oil, cloth, air, flame, &c. yet, by an exact scrutiny, some medium may perhaps be found to deaden this virtue more than any other medium, comparatively and in some degree.

Thus, suppose the loadstone would not attract iron so much through gold of a certain thickness, as through the same space of air, or not so much through ignited silver as through the same when cold, &c.; for we have not made the trials, but it is sufficient to propose them by way of example.**

In like manner, there is no body found here upon the earth but what is susceptible of heat, when applied to the fire, yet air receives heat much sooner than a stone; and, such is the substitution made in the way of degree or approximation.

* See Dr. Grew's Anatomy of Plants, as also that of Malpighi, and several Pieces to the same purpose in the Philosophical Transactions, French Memoirs, &c.

† See Harvey, Highmore, Malpighi, &c. upon this subject.

‡ Viz. Where she is removed from human sight, as she is in these grand Works, the Formation of Vegetables, Animals, and Minerals.

‖ See this subject prosecuted in the Author's History of Condensation and Rarifaction.

§ See the Author's History of Condensation and Rarifaction throughout.

** See below, Aph. 43.

The substitution by analogy is useful, but less certain, and therefore to be practised with judgement. This is performed when an insensible thing is brought down to the sense, not by the sensible operations of the insensible body itself, but by considering some other sensible body of kin thereto.

For example; if the subject of inquiry were the mixture of spirits, which are invisible substances, we are here to observe, that there seems to be a certain affinity between bodies, and the matter that feeds or nourishes them. Thus oil and fat bodies seem to be the food of flame, and water and aqueous bodies the food of air, for flames multiply themselves upon the exhalations of oil, and air upon the vapour of water. In this inquiry, therefore, we may consider the mixture of water and oil, which is manifest to the sense, though the mixture of air and flame is not perceptible; now, oil and water are very imperfectly mixed together by composition or agitation, but more curiously and elaborately in plants, blood, and the parts of animals; and, therefore, something of the like kind may happen as to the mixture of flame and air in untangible bodies; for, though flame and air do not well incorporate by simple motion, yet they seem to mix in the spirits of plants and animals, the rather, because all animal spirits prey upon both kinds of moisture, viz. the aqueous, the unctuous, as its aliment.*

In like manner, if the subject of inquiry be not the perfect mixture of pneumatical or untangible bodies, but only their composition, viz. whether they will easily mix among themselves; or rather suppose, for example, certain winds or exhalations, or other pneumatical bodies, which mix not with common air, but only lodge and float therein, under the form of globules and drops, as being rather broke and ground by the air, than received and incorporated with it. Now this cannot be perceived by the sense, either in common air or other pneumatical bodies, by reason of their subtilty or fineness, but a certain image or representation may be had of the thing, with regard to its possibility in tangible fluids, such as quicksilver, oil, water,† and even in air itself, when it is broke and dissipated, or rises in small particles or bubbles through water; and again, an image of it may be had in the grosser fumes;‡ and lastly, in dust raised and floating in the air; in all which cases there is no incorporation made. And this representation is not faulty, provided it be first carefully examined, whether among pneumatical bodies there may be such a heterogeneity as is found among liquors; for, in case there is, then these representations by analogy may be commodiously substituted.‖

And though, as we before observed, information is to be derived from these supplemental instances, by way of refuge or recourse, when proper instances are wanting; yet we would have it understood, that they are also of great use, even when the proper instances are procurable, particularly in strengthening the information, with the assistance of those. But the time for treating of these instances more exactly is when we come, by the law of order, to the helps of induction.§

* See the Axioms at the close of the History of Life and Death. See also Mr. Boyle's Experiments to this purpose. Abridgm. Vol. II. p. 469.

† These being heterogeneous fluids, and not mixing together upon shaking.

‡ Which do not incorporate with the air.

‖ See Mr. Boyle upon the different surfaces of fluids in contact. Abridgm. Vol. I. p. 316—318, and 388—396.

§ A part of the Novum Organum that is wanting.—See Part II. Aph. 21.

43. In the twentieth place come lancing instances, which we also, for a different reason, call by the name of vellicating instances. We call them vellicating instances, because they twitch the understanding, and lancing instances, because they cut or lance through nature, whence we also call them democrital instances,* that is, such as remind the understanding of the admirable and exquisite subtilty of nature, so as to excite and awaken it to attention, observation, and proper inquiry.

For example, the following are lancing or vellicating instances.—(1.) That so small a drop of ink in a pen should be drawn out into so many letters or lines, as we find it; (2.) that silver, gilt upon its external surface, should be drawn to such a vast length of gilded wire;† (3.) that so very small a worm as that found in the skin should have a spirit and a peculiar structure and organization of different parts; (4.) that a little saffron should tinge a whole hogshead of water;‡ (5.) that a little civet or musk should fill a large chamber with its odour; (6.) that such a great cloud of smoke should be raised from a little incense; (7.) that the exact differences of sounds should be every way conveyed through the air, and even through the holes and pores of wood and water, (though much weakened in the passage,) and be reflected with great distinctness and velocity; (8.) that light and colour should so suddenly pass through such a bulk of solid matter as glass, or of a fluid as water, yet so as at the same time to convey a great and exquisite variety of images, even though the light suffers refraction and reflection; (9.) that the loadstone should operate through all kinds of bodies, even the most compact and solid; and, what is still more wonderful, (10.) that, in all these cases, the action of one thing does not greatly hinder the action of another, in a neutral or indifferent medium, such as the air is. — Thus, numberless images of visible objects are carried through the air, numberless percussions of articulate voices, numberless specific odours, as those of violets, roses, &c. even cold, heat, and magnetical virtues, all pass through the air at once, without obstructing one another, as if each of them had its own separate way or passage, so as to prevent impinging against, meeting with, or obstructing, one another.

To these lancing instances may be advantageously subjoined those we term the limiting instances, with regard to this lancing, as, for example, in the cases just mentioned, that (1.) one action does not disturb or hinder another of a different kind, though two of the same kind damp or extinguish each other; that (2.) the light of the sun extinguishes or overpowers the light of the glow-worm; that, (3.) the report of a cannon drowns the voice; that, (4.) a stronger odour overpowers one that is more delicate; that, (5.) a stronger heat prevails over one that is more gentle; and, (6.) that an iron plate put between the load-stone and a needle hinders the magnetic virtue; but, the proper place of treating these instances, also, is under the helps of induction.‖

And so much for the instances of help to the senses, which are of capital use in the business of information, for information begins with

* Alluding to the Atoms of Democritus.—See the Author's Essay upon the Corpuscular Philosophy.

† See Mr. Boyle upon Effluvia, Abridgm. Vol. I. p. 485.

‡ See Mr. Boyle upon Effluvia, &c. Vol. I. p. 397, 438.

‖ A part not entered upon by the Author.—See Aph. 21 and 42.

the sense.* But the whole affair terminates in practice and works, which are the end, as information is the beginning;† and, therefore, the instances of principal use in practice are next to follow.

44. the instances of principal use in practice are of two kinds, and seven in number, all which we call by the general name of practical instances. Now, practice has two inconveniences, or defects, and so many general kinds of prerogative instances;‡ for practice either fails or overburdens. Practice fails principally from a wrong determination and measure of the powers and actions of bodies, especially after a diligent inquiry into the subject. But the powers and actions of bodies are circumscribed and measured, either (1.) by space of place;‖ (2.) by moments of time;§ (3.) by the correspondence or proportion of quantity;** or, (4.) by the predominancy of virtue;†† and, unless these four things are well and diligently weighed, the sciences, indeed, may, perhaps, be beautiful in show and appearance, but they will remain unfruitful or barren of works. And the four instances, with regard to these four particulars, we call, in general, mathematical instances, or instances of mensuration.‡‡

Practice proves burdensome either (1.) from the admixture of useless things;‖‖ (2.) from a multiplicity of instruments;§§ or, (3.) from the bulk of the matter and bodies required in certain works.*** Those instances, therefore, ought to be highly esteemed, which either (1.) direct and determine practice to such things as chiefly regard the benefit and advantage of mankind; or, (2.) retrench the number of instruments required; or, (3.) save and lessen the materials to be employed.

And the three instances corresponding to these three particulars or requisites, we call by the single name of propitious or benevolent instances.††† We shall speak of these seven instances separately, and with them conclude this section of the doctrine of Prerogative Instances.

45. In the twenty-first place, therefore, among Prerogative Instances, come instances of the staff, or measuring-rod, which we also call permeating or terminating instances; for, the forces and motions of things operate and exert themselves in certain spaces, that are not indefinite or fortuitous, but determinate and finite; and the due observance and marking of these spaces in every nature sought is of great importance to practice, not only in preventing us from being deceived by it, but also in enlarging and rendering it more extensive and powerful, for it is sometimes possible to extend virtues and powers, and, as it were, bring distances nearer, as we see in telescopes.

There are also many virtues that operate and extend their force only by manifest contact, as in the percussion of bodies, where one body does not move another, unless the impelling body touches the body impelled. So, likewise, external remedies, as unguents and plasters, exert not their virtues without touching the body; and, lastly, the ob-

* See Aph. 38.
† See Part II. Aph. 1.
‡ Viz. Two, corresponding to the two kinds of defects of practice; four defects of the first kind are enumerated in this paragraph, and three of the second in the next.
‖ See below, Aph. 45.
§ See below, Aph. 46.
** See below, Aph. 47.
†† See below, Aph. 48.
‡‡ Which see below, Aph. 45—48.
‖‖ See below, Aph. 49.
§§ See below, Aph. 50.
*** See below, Aph. 51.
††† See Aph. 49—51.

jects of the taste and touch do not strike or effect, if not contiguous to the respective organs.

There are also other virtues, which operate at a small distance, very few whereof have been hitherto observed, whilst there are more of them than men suspect. Thus, to give obvious examples, amber and jet attract straws and other light bodies. Bubbles of water, approaching each other, run together. Some purgative medicines draw the humour downwards, and the like: but that magnetic virtue, whereby iron and the loadstone, or loadstones themselves, meet each other, operates only in a certain little sphere of activity; but, if there be any magnetic virtue flowing from the inner parts of the earth to the needle, in respect of its verticity, the operation is performed at a great distance.

Again, if there be any magnetic virtue, which operates by consent, between the globe of the earth, and ponderous bodies; or between the globe of the moon and the waters of the sea, which seems highly probable from the spring tides; or between the sphere to the fixed stars and the planets, so as to attract the planets to their apogees, all these must operate at very great distances.

There are also found certain communications of flame to considerable distances, in certain materials, as they relate, in particular, of the Naphtha of Babylon. Heat likewise insinuates itself to great distances, and so does cold, insomuch that the huge masses of ice broke off and floating in the North Sea, and thence coming into the Atlantic Ocean, strike a coldness many leagues off, perceptible to the inhabitants about Canada.*

Odours, likewise, though these seem always attended with a corporeal emission of the odoriferous substance, operate at considerable distances, as appears to such as sail along the coasts of Florida, or some parts of Spain, where there are whole groves or woods of lemons, oranges, and the like odoriferous trees; or thickets of rosemary, marjoram, &c.† And lastly, sounds, but particularly the rays of light, operate to prodigious distances.‡

But all these virtues, whether they operate to small or large distances, certainly operate to finite ones, and such as are known to nature. so that there are certain fixed bounds which they cannot exceed, and that in proportion either, 1. to the bulk and quantity of the bodies; or, 2. to the strength or weakness of the virtues; or, 3. to the suitableness or unsuitableness of the medium, all which ought to be carefully observed, and brought to computation.‖ And again, the measures of those called violent motions, or the motions of projectiles, as bullets from guns, the motions of carriages, &c. ought to be observed and determined, for these also have manifestly their fixed limits.

There are, likewise, certain motions and virtues, contrary to those that operate by contact, and not at a distance, as acting at a distance, and not by contact; and again, others that operate weaker at a small distance, and stronger at a greater. Thus vision is not well performed in contact, but requires a certain medium, and a certain distance, to be perfect; though I have been assured, by a person of veracity, who was couched for cataracts in his eyes, (which is an operation performed by means of a small silver needle, thrust between the first coat of the eye,

* See Mr. Boyle's History of Cold. † See Mr. Boyle of Effluvia.

‡ See Mr. Boyle, Dr. Hook, Sir Isaac Newton, the Philosophical Transactions, French Memoirs, &c.

‖ Here we may observe the proper use of calculation, or mathematics, in physics.

to remove and force away the film of the cataract into the corner of the eye,) that he clearly saw the needle moving over the pupilla, or sight of the eye.*

But allowing this, it is manifest that larger objects cannot be well or distinctly seen, except in the vertex of a cone, made by the converging of the rays from some distance. Thus old men see better when the object is removed a little farther off, than when it is near. And it is certain, that in projectiles, the percussion is not so strong at too small a distance, as it is soon after, or at the due distance. The measures, therefore, of these things, and others of the like kind, are to be set down, to determine their motion in point of distance.

We must not omit another kind of local measure of motions, which regards not progressive but spherical motion; that is, the expansion of bodies into a larger sphere, or their contraction into a less. For we should inquire, among the measures of motion, what degree of compression or extension bodies, according to their nature, may easily and readily suffer, and at what point they begin to resist, and at length will sustain no more. Thus when a blown bladder is compressed, the air sustains some degree of compressure, but if the compressure be too great, the air enduring it no longer, bursts the bladder, and frees itself.

But to make a more exact experiment to this purpose, we took a small, light, and thin, metalline bell, and plunged it into a basin of water, so that it carried down along with it the air contained in its cavity to the bottom of the vessel, where we had first placed a little ball, which the cavity of the bell was to fall upon. When this ball was little in proportion to the cavity of the bell, the air shrunk itself into a less compass, without escaping; but if the ball was so large, that the air could not freely yield, the air would then, as being impatient of a greater pressure, raise up the bell, on one side, and ascend in bubbles.†

Again, to try what degree of extension air is capable of, we took a glass egg, with a small orifice at one end thereof, and by strong suction drew out the air, then immediately stopping the orifice with the finger, we plunged the glass in water, where the finger being removed, the air that was stretched and dilated by the suction, now endeavouring to contract itself, (so that if the glass had not been plunged in water, it would have drawn in the external air with a hissing noise,) it drew in such a quantity of water as sufficed to recover the remaining air to its former bulk or dimension.‡

And it is certain, that pneumatical, or rare bodies, such as the air, will suffer a remarkable contraction; but that tangible bodies, such as water, suffer compression with much greater difficulty, and in a less degree. What this degree might be, we attempted to discover by the following experiment.

We caused a hollow and strong globe of lead to be formed, capable of containing two wine pints, and having made a hole therein we filled the globe with water, then soldered up the orifice with lead, and now beat the sides of the globe flat out with a large hammer; whence the

* Sir Isaac Newton's Optics, particularly the queries at the end thereof.

† The design was here to estimate the force wherewith air resists its own condensation or endeavour to escape. See Mr. Boyle's Pneumatical Experiments, particularly Abridgm. Vol. II. p. 670—672.

‡ See Mr. Boyle's Works, Abridgm. Vol. II. p. 414.

water was of necessity contracted, because a sphere is the figure of largest capacity. And when hammering was of no farther service in making the water shrink, we put the lead vessel into a press, and squeezed it, till at length the water forced itself through the solid lead, and stood upon its surface like a dew. We afterwards computed into how much less space the water was driven by this violent pressure.*

But solid, dry, or more compact bodies, as stones, wood, and metals, sustain a much less and almost imperceptible compression and extension, and either release themselves by breaking, moving, squeezing out, or other evasions, as appears in the bending of wood or metal, in spring clocks or watches, in projectiles, hammering, and numerous other motions.

But all these particulars, together with their measures, are to be discovered and set down, in the inquiry into nature, either in the way of certain calculation, estimation, or comparison, as the case will admit.

46. In the twenty-second place, among our prerogative instances come instances of the course, or stage, which we also sometimes call hydrometrical instances,† deriving the term from the hour-glasses of the ancients, wherein they used water instead of sand. These instances measure nature by moments of time,‡ as the instances of the staff || measures them by degrees of space. For all motions, or natural actions, are performed in time; one indeed swifter, and another slower, but all in certain moments well known to nature. Even those actions which seem suddenly performed, or in the twinkling of an eye, as we phrase it, are yet found to differ in time, as to more or less.

And, first, we see that the revolutions or returns of the celestial bodies are performed in certain times or periods, so likewise is the flux and reflux of the sea. The descent of heavy bodies towards the earth, and the ascent of light bodies towards the heavens, is performed in certain moments, according to the nature of the body, and the medium it moves in. The motions of a ship, in sailing; of a horse, or other creature, in running; of a projectile, in flying, &c. are all, in like manner, performed in certain times, measurable in the amount or result.—And, with regard to heat, we see that boys, in the winter, will wash their hands in the flame of a common fire, without burning themselves; and, in the way of sport, others will, by a nimble and equable motion, turn glasses of wine, or water, upside down, and recover them again, without spilling; and there are many particulars of the same kind.

So likewise some compressions, dilatations, and eruptions, or explosions of bodies, happen swifter, and others slower, according to the nature of the body and the motion, but they happen in certain moments of time. Thus, in the joint explosion of several large cannons, which may be heard sometimes to the distance of thirty miles, the report is first audible to those near the place, where the discharge is made, and afterwards to those who are farther off.§

* See the Experiments of the Academie del Cimento; and Mr. Boyle's Works, Abridgm. Vol. I. p. 628, 629, Vol. II. p. 290, 666, 703, &c.

† As if it were instances of the time-keeper, or hour-glass.

‡ See Aph. 44. || See Aph. 45.

§ See Mr. Whiston's second edition of his Essay upon the Longitude; and Dr. Derham's Paper upon the Motion of Sounds, in the Philosophical Transactions, No. 313.

And in vision, where the action is exceeding swift, it is plain that certain moments of time are required to its performance, as is plain from this, that bodies are rendered invisible through too great a velocity of motion, as in the discharge of a bullet from a gun, where the ball flies too swift to have its impression received by the eye.

And, upon comparing this with the like cases, we have sometimes entertained a strange suspicion, viz. whether the stars of a clear sky be seen by us at the precise time they really exist, or rather somewhat later; and whether there be not, with regard to the sight of the heavens, a true and apparent time, as well as a true place, and apparent place, which is observed by the astronomers in the parallaxes. For it seems incredible that the rays of the celestial bodies should instantly travel such an immense distance to the sight, and not rather take up some considerable time in the journey.*

But this suspicion, as to any great interval betwixt the real and apparent time, afterwards vanished, upon considering that infinite loss and diminution of quantity, as to sight, between the real body of a star, and the apparent object, which difference is caused by the distance; and, at the same time, considering to what a distance objects that are barely white may, of a sudden, be seen here below, amounting to sixty miles at the least;† for there is no question but that the light of the celestial bodies has not only the vivid strength of whiteness, but also vastly exceeds the light of flame, as we find flame here in power and strength of radiancy. Nay, that immense velocity wherewith gross matter moves, in the diurnal rotation, renders this wonderfully swift motion of the rays of light, from the fixed stars, more probable. But what has the greatest weight with me is this, that if there should here be any considerable space of time between reality and sight, or the existence of the object and its being seen, it must then happen, that the sight would be frequently intercepted and confounded by clouds arising in the mean time, or by the like disturbances in the medium. And thus much for the simple mensuration of time.

The measure of motions and actions is not, however, to be sought only simply, but much rather comparatively, this being a thing of excellent use, and having regard to very many particulars. We find, that the flash of a great gun is seen before the sound is heard, although it is certain that the bullet must strike the air before the flame, which was behind it, could get out; and that this must happen from a greater velocity in the motion of light than in the motion of sound. We find, also, that visible objects are sooner received than let go by the sight, whence it is that the strings of a musical instrument, struck with the finger, appear double, or treble, in the vibration, viz. because a new object is received before the other is discharged; and for the same reason, rings twirling upon an axis seem spheres; and a lighted flambeau, carried hastily by night, appears tailed, like a comet.

And, from this foundation of the inequality of motion in point of velocity, Galilæo imagined the cause of the flux and reflux of the sea to be from the earth's revolving with a greater velocity than the waters;

* See this time computed by M. Huygens de la Lumiere, p. 8 and 9. See also Sir Isaac Newton upon the subject; and compare them both with the Papers of M. Maraldi in the French Memoirs, Ann. 1707.

† See, again, Mr. Whiston's Essay upon the Longitude.

whence the waters, gathering into a heap upwards, afterwards sunk down by degrees, as we see in a vessel of water briskly resolved. But this solution he invented barely upon supposition, and not upon proof, of the earth's motion, and also without being well informed of the sexhorary motion of the sea.

But we have an eminent example of the comparative measure of motion, and at the same time of its remarkable use, in the business of powder-mines, wherein vast masses of earth, piles of buildings, &c. are overturned and tossed into the air with a small quantity of gunpowder. — The cause whereof is doubtless this, that the motion of dilatation in the powder, which is the impelling force, is many degrees swifter than the motion of gravity, which makes the resistance; so that the prevailing motion is performed before the opposite motion begins, whilst at first there was a kind of neutrality, or want of resistance. And hence, in all projectiles, it is not so much the strong as the sharp and quick stroke, or percussion, that carries the body farthest. Nor was it possible that a small quantity of spirit in animals, especially in those so bulky as the elephant, or the whale, should move and manage so great a mass of matter, but for the velocity of the motion of the spirit, and the inability of the corporeal mass to resist.

And this is one of the principal foundations of the magical instances, which we shall soon consider,* wherein a small quantity of matter overpowers and subdues a much greater; that is, where there may be a preoccupation, or anticipation of motions, by the velocity of one, before another is ready.†

Lastly, this business of anticipation and subsequence should be observed in all natural actions. Thus in the infusion of rhubarb, the purgative virtue is drawn out first, and the astringent virtue afterwards.‡ — And something of the like kind we have found upon infusing violets in vinegar,‖ where the sweet and delicate odour of the flowers is first received, and afterwards the more earthy part, which confounds the odour; therefore, if violets be infused for the whole day, their smell is obtained much fainter than if they were infused only for a quarter of an hour, and then taken out. And because violets contain but little odoriferous spirit, if fresh ones be infused in the same liquor, every quarter of an hour, for six times, the tincture, or infusion, will become so rich in the space of an hour and a half, as to continue, for a whole year, of an exceeding grateful odour, not inferior to the flowers themselves. But it must be observed, that the odour does not come to collect its full strength till a month after the infusion is made. And the business of distillation affords numerous remarkable examples to the same purpose.

47. In the twenty-third place, among prerogative instances, come instances of quantity, which we also call the doses of nature,§ borrowing the expression from medicine. These are such instances as measure virtues by the quantities of bodies, and indicate what the quantity of a body contributes to the quantity of virtue.

* See Aph. 51.

† This deserves to be carefully considered and remembered; for many extraordinary operations and cases of practice depend upon it.

‡ See the Sylva Sylvarum, under the article Infusion.

‖ See the last cited.

§ See Aph. 44.

And, first, there are certain virtues subsisting only in a cosmical quantity; that is, such a quantity as has a consent with the configuration and structure of the universe. Thus the whole body of the earth, unmoved suppose in its whole, does not fall downwards, though its parts do; the waters ebb and flow in the sea, but not in rivers, unless where they communicate with the sea; and almost all particular virtues operate in proportion, as the body is bigger or less. Large collections of water do not easily corrupt, as small ones do. New wines and drinks ripen quicker, or become sooner potable, when contained in small vessels, than when in large ones. If a plant be added to a large proportion of liquor, it makes an infusion rather than a tincture; but if to a less, it makes a tincture rather than an infusion. So, with regard to the human body, bathing is one thing, but sprinkling another. And thus the finest dews never fall in the air, but are dissipated and incorporated with it. And we see in breathing upon polished gems, that the small quantity of moisture thus left upon their surface, is presently licked up by the air, as a light cloud, or mist, is dissipated by the wind. Again, a piece of loadstone will not attract so much iron as the whole loadstone would do.

There are also virtues, wherein smallness of quantity has the greatest effect, as a sharp point penetrates easier than a blunt one, and as the angular point of a diamond cuts glass; with other examples of the like kind.

But we are not here to dwell upon indefinites, but should inquire into the proportions of the quantity of a body, with regard to the measure of its virtue; for one might easily imagine, that the proportions of quantity corresponded to the proportions of virtue, as that a leaden bullet of two ounces should fall twice as swift as another of one ounce, which is absolutely false. Nor do the same but very different proportions obtain in all kinds of virtues; and, therefore, these measures must be derived from experiments, and things themselves, and not from probabilities or conjectures.

Lastly, in every natural inquiry, the quantity of the body required to produce any effect must be set down as the dose, and the cautions, with regard to quantity, either in excess or defect, continually interspersed.

48. In the twenty-fourth place come instances of reluctance, which we also call by the name of prevailing instances; that is, such as shew the predominancy or subjection of virtues to one another, or which of them is the stronger and prevails, and which the weaker and submits; for the motions and struggles of bodies are no less compounded, recompounded, and complicate, than bodies themselves. We will, therefore, first lay down the principal species of motions, or active virtues, that their comparison, in point of strength, may be the clearer; and thence the instances of reluctance and prevalence be the better known and designed.

The first motion may be the motion of resistance in matter, or the motion that resides in all the parts thereof, and will not suffer it to be any way annihilated; so that no force of fire, no weight or depression, no violence, no length of time, or continuance of duration, can ever possibly reduce any the least particle of matter to nothing, but it will still continue something; possess a certain space, and, to whatever necessity it be reduced, free itself, either by changing its form or place, or,

if it cannot do that, it will continue as it was, so that the time shall never come when it is nothing, or has no existence. And of this motion we need produce no examples, because it is universal, or exists in all bodies.*

Let the second motion be that we term motion of connexion, whereby bodies suffer not themselves to be divided or separated from others, on account of the mutual contact and connection they affect, which is a motion called by the schools the motion preventive of vacuity, as when water is forced upwards by suction, or by the pump, or when the flesh is raised by cupping-glasses, or as when water runs through a siphon, with numerous other examples of the same kind.†

Let the third motion be what we call motion of liberty, or freeing motion, whereby bodies endeavour to ease and free themselves from any preternatural pressure or tension, or restore themselves to the dimensions agreeably to their own natures. And of this motion also the examples are numerous. Thus water endeavours to free itself from pressure in the action of sailing and rowing, the air in the action of flying and in the undulations of the winds, the springs in watches, compressed air in pop-guns, which forces out the pellet, &c.

And, for this motion of liberty in the case of tension, we see the air frees itself therefrom, when it remains after suction in glass eggs ;‡ we see it also in strings, leather, cloth, &c. which restore themselves after tension, unless where they remained so long stretched, as to have their motion of liberty subdued. This motion is unscientifically called by the schools the motion of the elementary forms, for it does not only belong to air, water, and flame, but to all the diversities of consistent bodies, as wood, iron, lead, skins, cloth, &c. each body having its own measure of extent or dimension, whence it is with difficulty stretched to any considerable distance.‖

But, as this motion of liberty is of all others the most obvious, and also extremely general, it requires to be well and clearly distinguished; for, some very inadvertently confound it with the motion of resistance and the motion of connexion. Thus, when by this motion matter frees itself from pressure, they confound it with the motion of resistance, and when matter frees itself from tension, they confound it with the motion of connexion, as if compressed bodies yielded or dilated themselves only to prevent a penetration of dimensions; and as if, when stretched, they restored or contracted themselves to prevent a vacuum, whereas, if compressed air were to become as dense as water, or wood as dense as stone, there would be no danger of a penetration of dimensions, even though these bodies could be much farther compressed than they any way admit of. So likewise, if water were to be dilated to the same degree of rarifaction with air, or stone to the same degree of rarifaction with wood, there is no necessity that a vacuum should ensue, even though these bodies could be extended much far-

* See the Author's History of Condensation or Rarifaction.

† Let it be considered, whether all these motions are justly explained by the weight, spring, or pressure, of the air.

‡ See Aph. 45.

‖ See the History of Condensation and Rarifaction, and the article Motion in the Sylva Sylvarum.

ther than their natures any way allow.* And, therefore, the case is not brought to a penetration of dimensions and vacuity, except in the utmost limits of condensation and rarifaction, whereas these motions stop far short of those limits, as being no more than appetites which bodies have of continuing themselves in their own consistencies or dimensions and not suddenly departing from them, unless altered by gentle means and by consent.

But it is much more necessary, as being a thing of great consequence, to observe, that violent motion, as it is called, is no other than this very motion of liberty, tending from compression to relaxation; for, in all simple protrusion or flight through the air, there is no tendency to motion or change of place before the parts of the body suffer preternaturally, and are compressed by the impelling force; whence it is that some parts successively pressing against the rest, the whole body is driven off or protruded, and not only in a progressive, but at the same time in a rotatory or revolating motion, so as that, by this means also, the parts may free themselves or suffer more equally.

Let the fourth motion be the motion of extension, which is, in some measure, the opposite to the motion of liberty; for, in the motion of liberty, bodies avoid, dread, and fly from, a new dimension or a new degree of dilatation or contraction, and endeavour, with all their force, to recover their former state; whereas, on the contrary, in the motion of extension, bodies affect a new dimension, and sometimes willingly and hastily aspire to it, even with a violent endeavour, as we see in gunpowder. And the most powerful, or at least the most common, though not the only, instruments of this motion are heat and cold.

For example; if air be dilated by tension, as it is in suction, it has a great appetite of restoring itself; but, if heat be applied thereto, it, on the contrary, tends to dilate and occupy a new dimension, and goes willingly over thereto, as into a new state, and, after some continuance of this dilatation, it has no great appetite to return, unless solicited thereto by the application of cold, which is no spontaneous return, but a repeated change.

So likewise water, when compressed, resists and endeavours, as it were, to enlarge itself: but, upon the continuance of intense cold, it spontaneously and readily concretes into ice; and if the cold continues very long, without interruption from any warmth, as perhaps sometimes happens in the deeper caverns, the water is turned into crystal, or matter approaching thereto, and never recovers the nature of water again.†

Let the fifth motion be the motion of continuity, by which we do not mean a simple and primary continuation with any other body, for that is motion of connexion, but of self-continuation in a certain body; for it is manifest, that all bodies resist a solution of their continuity; some indeed more, others less, but all of them in a degree. And, as in hard bodies, such as steel and glass, the resistance of discontinuation is very strong, so likewise in liquors, where this motion seems either to cease, or at least to languish, yet it is not absolutely wanting, but it plainly resides in them, as it were, in the lowest degree, and dis-

* See the Author's History of Condensation and Rarifaction.

† See the Sylva Sylvarum, under the article Transmutation. See also Mr. Boyle upon the Origin of Gems.

covers itself by numerous experiments, as particularly in bubbles, the sphericity of drops, the fine threads of icicles, in the drawing out of glutinous bodies, &c. But this appetite principally appears, when a discontinuation is attempted in the small parts of bodies; thus, in beating the mortar, after the pulverization is carried to a certain degree, the pestle operates no farther upon the matter to reduce it finer. And so water will not enter into fine cracks, or fissures; nor air, though so extremely subtile, readily insinuate into the pores of solid vessels.

Let the sixth motion be that we call motion of acquisition, or motion of want, by which bodies, when placed among others that are heterogeneous to, and, as it were, at enmity with, them, if they find an opportunity of flying and avoiding these, and applying themselves to others nearly related, though without any close or intimate consent, yet they presently embrace the occasion, and choose the latter before the former, as it were, in the way of acquisition, or as if they stood in want of such bodies, whence we derive the name.

For example, leaf-gold, or any other metal in the leaf, delights not in the ambient air; and, therefore, if it touches any tangible or gross body, as the finger, paper, &c. it presently sticks thereto, and is not easily separated again.

So paper, cloth, &c. have no great agreement with the air residing or lodged in the pores thereof, and therefore such bodies readily imbibe water or other moisture, and reject, or throw out the air. So, if sugar or sponge be dipt only at one end in water or wine, whilst the other part remains far above the surface of the liquor, yet these bodies gradually attract the wine and water upwards.*

Hence we may derive an excellent rule for the opening and dissolving of bodies; for, (not to meddle at present with corrosive menstruums, which force themselves a passage,) if a suitable body can be found that has a greater agreement or consent with any solid than the matter has wherewith such a solid is mixed, as it were, by necessity,† the solid will immediately open and relax itself, to receive the latter and exclude and reject the former.‡ Nor does this motion of acquisition operate only in immediate contact, for the electrical virtue (about which Dr. Gilbert and others have invented such fables) is an appetite excited by a gentle friction, and not well agreeing with or enduring the air, but affects or covets other tangible bodies, if it finds them near at hand.‖

Let the seventh motion be that we call the motion of the greater congregation, whereby bodies are carried to the masses of their own natures,—heavy ones to the globe of the earth, and light ones to surrounding heavens.—This, by the schools, from a superficial conside-

* See the Sylva Sylvarum, under the article Attraction.

† The Instances hereof are numerous in chemistry, as in adding oil of vitriol to nitre, sea-salt, &c. when the oil of vitriol seizes upon the earthy part, and sets the spirit of nitre, &c. free.

‡ See the article Attraction in the Sylva Sylvarum. See also the Chapter of Menstruums in Boerhaave's Chemistry; and M. Geoffroy's Table of the different relations observed in Chemistry, betwixt different bodies, in the French Memoirs. Ann. 1718.

‖ See Mr. Boyle of Electricity. See also the Author's Sylva Sylvarum, under the article Electricity.

ration is called natural motion, because they found nothing that was externally visible to give it, and therefore imagined it to reside naturally, or to be innate in things themselves; or again, perhaps, because it is a ceaseless or continual motion. And no wonder, since the heavens and the earth are always at hand, whereas the causes and origins of many other motions are sometimes present and sometimes absent, and hence they laid this down for a constant and proper motion, and the others for acquired ones.

But, in reality, this motion is weak and languid, as yielding and submitting to other motions, so long as they continue to operate, unless the bulk of the body be considerable. And, although this motion has so possessed the thoughts of men as almost to have stifled or superseded the rest, yet it is very little that they know thereof, but run into many errors about it.*

Let the eighth motion be the motion of the smaller congregation, whereby the homogeneous parts in any one body separate themselves from the heterogeneous, or collect together, and whereby also distinct and entire bodies, from a similitude of substance, embrace, cherish, and sometimes collect and attract, each other, and come together from a certain distance, as when in milk, the cream, after some continuance, floats a-top, and in wine the lees sink to the bottom. Nor does it happen only through the motion of gravity and levity, that some parts should rise to the top and others sink to the bottom; but much more through an appetite, that homogeneous bodies have of meeting and uniting together.

This motion differs from the motion of want in two respects; the one, that in the motion of want there is a stimulus or incitement of a malignant and contrary nature, whereas in this motion, when all obstacles and impediments are removed, the parts unite by congruity or affection, though there be no foreign nature present to cause aversion. The other respect is, that the union here proves closer, and, as it were, stronger, with greater appetite or choice; for, in the former, if the thing at enmity be avoided, the bodies meet, though they are not greatly related; but, in the latter, substances come together, as if perfectly related by similitude, and make, as it were, one whole. — And this motion resides in all compound bodies, and would easily shew itself in each, if it were not bound down and restrained by other appetites and necessities of bodies which disturb and hinder this union.†

This motion is generally bound down three ways, viz. 1. by the inactivity of bodies; 2. by the check of a predominating body; and, 3. by external motion. As to the first, it is certain that tangible bodies have a kind of inactivity or sluggishness, in a greater or less degree, whereby they dread or resist local motion, so that, unless excited, they tend rather to continue in their present state than to move or change for a better.‡

* See the article Motion, in the Sylva Sylvarum.

† These appetites, or laws of motion, require the strictest regard, as being the things whereon all the actions and passions, or all the phænomena and affects of bodies, principally depend.

‡ This seems to be what is now called, by mathematical writers, the vis inertiæ of matter.

This sluggishness is taken off by three means, viz. 1. either by heat; 2. some eminent virtue of a body related; or, 3. by a brisk and powerful motion. And, first, as to the assistance of heat, it hence arises, that heat is said to separate heterogeneous and congregate homogeneous bodies, which is a definition of the Peripatetics, justly derided by Dr. Gilbert, as being like the defining a man to be a thing that sows corn and plants vineyards, a definition formed only upon particular effects. But the former definition is still more faulty, because the effects, whatever they are, proceed not directly from the property of heat, but only by accident. for cold will do the same, as we will shew hereafter,* and is really owing to an appetite which the homogeneous parts have of coming together, the heat only assisting to dispel the sluggishness that before subdued or bound down this appetite.

Secondly, as to the assistance of the virtue communicated by a body related, this appears surprizingly in the armed loadstone, which excites in iron a virtue of detaining iron, by similitude of substance, the virtue of the magnet here dispelling the sluggishness of the iron.

And, thirdly, for the assistance of motion, we see it in arrows of wood, with wooden points, which penetrate farther into wood than if they were tipt with iron, through a similitude of substance, the inactivity of the wood being shook off by the velocity of the motion, as we before observed, under clandestine instances.†

The binding of the motion of the smaller congregation, by the check of a predominating body, appears in the resolution of blood and urine, by cold, for, so long as these fluids continue full of that active spirit which directs, governs, and subdues, their parts, of every kind, as lord of the whole, so long as the different parts do not collect together, by reason of the check upon them; but, after this spirit is evaporated or deadened by cold, then the parts, being relaxed and unbridled, severally come together, according to their natural appetites. And hence it is that all bodies containing a sharp spirit, as salts, and the like, continue unseparated,‡ viz. by reason of the permanent and durable check of the presiding or over-ruling spirit.

We have an eminent example of the motion of the smaller congregation being subdued by external motion in the agitations of bodies, which are preventive of putrefaction, for all putrefaction depends upon the uniting of the homogeneous parts, whence there gradually ensues a corruption or destruction of the former state or appearance, and the introduction of a new one; for, a solution of the old state must precede putrefaction, which paves the way to the generation of a new thing. And this solution is the collection of the homogeneous parts together: and, if not obstructed, the solution is simple; but, if various obstacles intervene, putrefaction ensues, that is, the rudiments of a new generation; but, if a frequent agitation be made by external motion, then the motion of union, which is here delicate, soft, and requires rest from without, becomes disturbed, and ceases, as we find by numerous examples.

* As particularly in the freezing of brandy, wine, saline liquors, &c.—See below, Aph. 50.

† See Aph. 25.—See also the Sylva Sylvarum, under the article Attraction.

‡ Viz. Unresolved into their different principles or heterogeneous parts.

Thus the continual agitation or running of waters prevents their putrefying; winds purge and purify a pestilential air; corn, by being turned and agitated, is kept sound in the granary; and, in short, all things that are kept in agitation from without, do not easily putrify from within.*

We must not here omit that conjunction of the parts of bodies, whence hardness and dryness principally proceed; for, after the spirit, or moisture turned into spirit, is fled from any porous body, as wood, bone, parchment, &c. the grosser parts forcibly contract and come together, whereupon hardness or dryness ensues, which we judge not to proceed so much from the motion of connection, as from the motion or appetite of amity or union.

As for the motions that meet from a distance, these are extraordinary and uncommon, yet may be found in more things than have been usually observed. We find examples hereof in bubbles, that rush into and dissolve one another; in medicines, that attract or drain off humours by similitude of substance;† two violins in unison with each other, when the one being struck, the other will move, &c. We likewise suspect this motion prevails in the spirits of animals, though it remains perfectly unknown. It is doubtless exerted in the loadstone and animated iron.

But with regard to the loadstone, there are four distinct motions, virtues, or operations, that should not be confounded, though, through admiration and astonishment, men have blended them together.—The first is, the attraction betwixt magnet and magnet, iron and the magnet, or animated iron and iron. The second is, the verticity of the touched needle, or its property of pointing north and south, together with its variation or declination from that direction. — The third is the virtue of penetrating gold, glass, stone, &c. And the fourth is the communication of virtue from the stone to iron, and from iron to iron, without a communication of substance.‡ But, at present, we speak only of the first of these virtues, that of approach or attraction.

There is also a remarkable motion of attraction between quicksilver and gold, so that gold will attract quicksilver, though it be made up into ointments.—And those that work much among the vapours of quicksilver, commonly hold a piece of gold in their mouths, to collect the mercurial effluvia, which would otherwise penetrate the skull and bones of the body, &c. and the gold so employed soon after becomes white.|| And so much for the smaller congregation.

Let the ninth motion be magnetical motion, which, though a thing of the same kind with the motion of the smaller congregation, yet, if it operate to great distances, and upon large masses of matter, it deserves a separate inquiry, especially, if it neither, like most other motions, begins with contact, nor comes to that at last, as all the motions of congregation do, but only raises bodies, or makes them swell, with-

* See the Sylva Sylvarum, under the article Putrefaction.

† Viz. As rhubarb does the bile, &c.

‡ See the article Magnetism in the Sylva Sylvarum.

|| It has been lately questioned, whether, when persons have been salivated by mercury, a piece of gold will be whitened by being held, for several hours, to any part of the body where no mercury from without is supposed to come, or none besides what has passed through the course of circulation, along with the animal juices.

out any farther effect; for, if the moon raises the waters, or makes moist things swell, or if the sphere of the fixed stars attracts the planets towards their apogees, or if the sun attracts Venus and Mercury, and keeps them always near its body, these motions seem not justly to fall under those of the greater or less congregation, but to be certain middle and imperfect motions of assemblage, that should therefore constitute a particular species.

Let the tenth motion be the motion of avoidance, which is a motion contrary to that of the smaller congregation, and makes bodies by antipathy* fly from and keep off others that are disagreeable to them, or separate themselves therefrom, or refuse to mix therewith; for, although this motion may seem, in some cases, to be only an accidental or a consequential thing, with respect to the motion of the smaller congregation, as homogeneous bodies cannot come together till such as are heterogeneous be excluded and removed, yet it should be particularly mentioned, and made a species, because in many things the appetite of repulsion seems more capital than the appetite of attraction.

This motion appears remarkably in the excretions of animals, and no less in the objects odious to some of the senses, particularly to the smell and taste; for a fœtid odour is so repulsed by the organ of smell, that it even causes a motion of expulsion, by consent, in the mouth of the stomack.† A bitter and horrid taste is so repulsed by the palate and throat, as to cause, by consent, a particular shake or shuddering of the head.

This motion of avoidance has also place in other things, for it appears in some kinds of antiperistasis. Thus the cold in the middle region of the air seems to be a repulsion of the cold from the confines of the celestial bodies, as those great heats and burnings, found in subterraneous places, seem to be a repulsion of heat from the inner parts of the earth; for, heat and cold destroy each other when their degrees are small; but, when collected into large masses, or, as it were, into full armies, they violently repel and displace each other in the conflict.

It is also reported, that cinnamon and other odoriferous bodies, suspended in a jakes or other fœtid place, retain their scent longer, as thus keeping themselves within, and refusing to mix with matters of an ill odour. And quicksilver, which of itself unites into a continued mass, is, by grinding with a little spittle, turpentine, &c. kept asunder, so that its parts unite not again, by reason of the aversion they have to the bodies employed, from which, as every way mixed in among them, they shrink, and shut themselves up, their appetite of avoiding these particles interposed being greater than their appetite of uniting with their own similar parts; and this is what they call the killing of quicksilver.

So again, the reason that oil will not mix with water is not so much owing to their difference of gravity as to their want of consent, which appears hence, that spirit of wine, though lighter than oil, yet mixes with water. But the motion of avoidance is most remarkable in

* Let it always be remembered, that the Author constantly chooses the old words, where he may use them so as to convey his own meaning with any tolerable advantage. This is the more necessary to be remarked, because men are extremely apt to take particular disgusts, as well as particular likings, to words and phrases.

† Viz. A retching.

nitre, and the like crude bodies, which fly from flame, as we find in gunpowder, quicksilver, and gold.*

Let the eleventh motion be the motion of assimilation, motion of self-multiplication, or motion of simple generation. By simple generation, we do not understand the generation of entire bodies, such as plants and animals, but of similar bodies, so that, by this motion, bodies convert other bodies related to them, or at least such as are well disposed and prepared to be converted into their own substance and nature.

Thus flame multiplies itself upon unctuous exhalations and oily bodies and generates new flame; air multiplies itself upon water, and produces new air; and the vegetable and animal spirit multiplies itself, or feeds upon the soft, aqueous, and oleaginous parts, and begets new spirit; the solid parts of plants and living creatures, as the leaves, the flowers, the flesh, the bones, &c. are all assimilated from the juices of the aliment, and thus beget new matter and new substance upon themselves successively;† for, let no one dream, with Paracelsus, (who appears as if blinded by his distillations,) that nutrition is performed merely by separation, and that the eyes, the nose, the brain, the liver, &c. lie concealed in bread or food, or that the roots, the leaves, and flowers, of vegetables, are lodged in the juice of the earth; for he asserts, that, as the workman, by separating and paring off what is superfluous from a rude block of stone or wood, educes out of it a leaf, a flower, an eye, or a nose; so the archæus, that internal operator of his, produces all the different limbs and parts out of the aliment, by separation and rejection.

But, to leave such trifling:—it is certain, that all the parts, as well similar as organical in vegetables and animals, first attract with some election or choice, nearly the same common, or not very different juices, for their aliment, and afterwards assimilate or convert them into their own nature.‡

Nor is this assimilation, or simple generation, performed only in animate bodies, but inanimate bodies also partake thereof, as was formerly observed of flame and air.‖—And even the languid spirit contained in all tangible inanimate bodies constantly endeavours to digest the grosser parts, and turn them into spirit to be afterwards discharged, whence proceed diminution of weight and dryness, as was formerly observed.§

Nor must we, in the business of assimilation, reject that accretion commonly distinguished from assimilation, as when clay, mixed among stones, concretes and is turned into a stony matter, or when the scales of the teeth are turned into a substance as hard as the teeth themselves, &c. For we judge that all bodies have an appetite of assimilating, as well as of uniting, what is homogeneous to themselves, but that both powers are bound down or suppressed, though not in the same manner. All these ways of binding, and the correspondent ones of loosing,

* Viz. Quicksilver confined and heated, and in the Aurum Fulminans.

† See the History of Life and Death, the History of Winds, and the Sylva Sylvarum.

‡ See the Sylva Sylvarum, under the article Vegetation.

‖ See Aph. 42.

§ See Aph. 40.

should be diligently inquired after, because they regard the prolongation of life, or the alleviation of old age.*

Lastly, it is worth observing, that in the ten preceding motions bodies seem only to affect or endeavour the preservation of their own natures: but in this eleventh to endeavour their propagation.

Let the twelfth motion be the motion of excitation, which seems of the same kind with the motion of assimilation, as being diffusive, communicative, transitive, and multiplicative, like that, so as generally to agree therewith in the effect, though they differ in the subject and manner of effecting; for, the motion of assimilation proceeds with a kind of sway, authority, and power, as it commands and compels the matter assimilated to turn and change into the matter assimilating, whereas the motion of excitation proceeds as if it were by art, insinuation, and stealth, thus soliciting and disposing the excited matter to assume the nature of the matter exciting. So again, the motion of assimilation multiplies and transforms bodies and substances, and thus produces more flame, more air, more spirit, more flesh, &c. but, in the motion of excitation, none but virtues are multiplied and communicated; whence there is generated more heat, more magnetism, more putrefaction, &c.

And this motion is remarkably found in heat and cold; for heat does not diffuse itself in heating by the communication of the original heat, but only by exciting the parts of the body to that motion which is the form of heat, as was mentioned above,† and therefore heat is much slower and more difficultly excited in stone or metal than in air, by reason of the indisposition and unfitness of those bodies to admit of that motion; whence, possibly, there may lodge in the bowels of the earth matters which cannot be heated, as being by a greater condensation deprived of that spirit with which this motion of excitation generally begins.‡

So the magnet gives iron a new disposition of parts and a conformable motion, whilst itself loses nothing of its virtue. — So likewise bakers' leaven, yeast, rennet, and certain poisons, respectively excite and solicit a successive and continued motion in the coming of cheese, the making of bread, the fermenting of beer, and in poisoning the human body; and this not so much by the power of the exciting matters as by the predisposition and easy yielding of the bodies excited.

Let the thirteenth motion be the motion of impression, which likewise seems of the same kind with the motion of assimilation, and is the most subtile of diffusive motions, but we think proper to make it a species by itself, because of a remarkable difference it has in respect of the two former; for the simple motion of assimilation transforms bodies themselves, so that, if what gave the first motion be removed, it is of no significance to what follows; for the first lighting up of flame, or the first conversion into air, makes nothing to the succeeding generation of flame or air. So likewise motion of excitation remains perfect for a considerable time after the first mover is taken away, as in a heated body, after what gave the first heat is removed; in ani-

* See the Author's History of Life and Death.

† See Aph. 13 and 20.

‡ Consult the tables above laid down, Aph. 11, 12, 13, 18, 20.

mated iron, after the loadstone is laid aside; and in bread, before baking, when the leaven is taken away. But the motion of impression, though it be diffusive and transitive, yet seems constantly to depend upon the first mover, so as if that be taken away, it immediately ceases, and comes to nothing. This motion is, therefore, performed momentaneously, or at least suddenly, for which reason we call the motions of assimilation and excitation the motions of Jupiter's generation, because the generation remains; but this motion of impression, the motion of Saturn's generation, because the offspring is presently devoured and swallowed up.

This motion shews itself in three things, viz. 1. the rays of light; 2. the percussion of sounds; and, 3. the communication of magnetical virtues. For, 1. when light is removed, colour and all visible appearances immediately vanish; and, 2. upon removal of the first percussion, and the concussion of the body consequent thereto, sound soon vanishes. For, although sounds are tossed and agitated in their medium by winds, as it were by waves, yet it must be carefully observed, that sound does not continue so long as the resounding continues. For, when a bell is struck, the sound seems to continue a good while after, but it would be very erroneous hence to conceive, that the sound fluctuated, and hung in the air, all that while; for the resounding is not the same numerical sound, but a new one, as appears plainly by stopping the body struck; so if the bell be strongly compressed whilst it resounds, and be thus rendered motionless, the sound instantly ceases, and no more resounding is heard. So likewise in stringed instruments, if the string be touched with the finger, after the first percussion, the resounding presently stops. 3. And, lastly, when the magnet is removed, the iron suspended by it presently falls down; but the moon cannot by us be removed from the sea, nor the earth from a ponderous body in falling; and therefore no experiment can, in this respect, be made on them, though the case be otherwise the same.*

Let the fourteenth motion be the motion of configuration, or situation, whereby bodies seem not to affect coming to or flying from one another, but a certain position, situation, and configuration, with respect to others. This indeed is a very abstruse motion, and little inquired into; and, in some cases, it seems to be without a cause, though we judge it not to be really so.

Thus, if it should be asked why the heavens revolve from east to west, than from west to east, or turn upon poles placed near the north and south, or nearer the bear, than near Orion, or any other fixed star, the question would appear wild and surprizing, as being supposed a thing that ought to be received from constant observation and experience. And, it is true, there are in nature certain ultimate resorts, and things without a cause; but this does not seem to be one of them. For we judge it to proceed from a certain harmony and consent of the universe, hitherto unobserved. And if we admit the motion of the earth from west to east, the same question would recur, because the earth also must move upon certain poles; but why should these poles be placed rather where they are, than elsewhere?

So likewise the verticity, or the direction and variation of the mag-

* Sir Isaac Newton attempts to shew, by calculation, that the moon, and whole solar system, may be sensibly affected by the attraction of the earth, and conjectures that the effect will become more sensible hereafter, by causing a great disturbance in the celestial motions. See Newton, Princip. Lib. III.

netic needle, may be referred to this motion of configuration. And there are found in bodies, both natural and artificial, especially such as are consistent, and not fluid, a certain disposition and situation of parts, as it were in the manner of threads and fibres, which arrangements should be diligently sought after; for, without a discovery thereof, such bodies cannot be commodiously treated, managed, or wrought.*

Let the fifteenth motion be the motion of transition, or motion of passage, whereby the virtues of bodies are more or less hindered, or promoted, on account of their mediums, according to the nature of the body, and the virtue of the medium; for one medium suits best with light, another with sound, another with heat and cold, another with magnetic virtues, &c. respectively.

Let the sixteenth motion be what we call by the name of regal, or political motion, whereby the parts predominating and ruling, in any body, curb, subdue, and regulate the other parts, and compel them to unite, separate, fix, move, and range themselves, not according to their own appetites, but as it is conducive to the well-being of that over-ruling part, so as to make a kind of political government, exercised by the ruling part over the parts in subjection to it.

This motion principally reigns in the spirits of animals, and regulates and tempers all the motions of the other parts, so long as itself remains in vigor. It is also found, in a less degree, in other bodies, as was said above of blood and urine, which do not resolve till the spirit that mixed and held their parts together is evaporated or stifled. Nor is this motion peculiar to spirits, though these govern or preside in most bodies, by reason of their velocity and penetration; but in bodies more condensed, and not full of a vivid brisk spirit, (such as is found in quicksilver and vitriol,) the gross parts rather have the ascendant, so that unless this yoke, or obstacle, could by some means be shook off or removed, there are no hopes of any new transformations to be wrought in such bodies.

Let no one here imagine, that we forget our immediate business, and (whereas this arrangement and distribution of motions regards nothing more than the better inquiring into and discovering their predominancy by the instances of reluctance†) here treat of this predominancy among the motions themselves; for in the description of this regal motion, we do not treat of the predominancy of motions or virtues, but of the predominancy of the parts in bodies, this being that predominancy which constitutes the peculiar species of motion at present under consideration.

Let the seventeenth motion be the spontaneous motion of rotation, whereby bodies in motion, and favourably situated, enjoy their own nature, follow themselves, and no other thing; but run, as it were, into their own embraces. For bodies seem either to move without any certain end, or perfectly to rest, or else be carried to a period where they may either revolve or rest, according to their nature. But the bodies that are favourably situated, if they move at all, move in a circle; that is, with an eternal and infinite motion. The bodies that are well situa-

* Thus, for example, the diamond is flaky or leafy, and has a grain, or a perpetual situation of plates, so as, in this respect, to resemble talc, &c. Wood has its grain, or longitudinal direction of fibres, &c. And the knowledge of those properties in bodies directs the ways of treating or managing them, as we see in the cutting and polishing of diamonds, the splitting and planing of wood, &c.

† See Aph. 48.

ted, and yet abhor motion, are perfectly at rest; but such as are not well situated move in a strait line; that is, in the shortest way, to the association of bodies of their own nature.

This motion of rotation has nine differences, regarding, 1. the centre about which the motion is performed; 2. the poles, with regard to which they move; 3. the circumference, in respect to its distance from the centre; 4. the degree of velocity; 5. the consecution or order of the motion, as whether from east to west, or west to east, &c.; 6. the declination from a perfect circle, by spirals, farther off, or nearer to the centre;* 7. the declination from a perfect circle, by spirals, farther from or nearer to the poles; 8. a greater or less distance of the spirals from one another: 9. and lastly, the variation of the poles themselves, if moveable; which particulars belong not to rotation, unless it be circular.

And this motion, according to common and more settled opinion, is held to be the proper motion of the heavenly bodies. But there is a great controversy, with regard to this motion, between certain of the ancients, as well as the moderns, who, some of them, attribute rotation to the earth. But, perhaps, it were a more proper subject of controversy, (if the thing be not already past dispute,) whether this motion, supposing the immobility of the earth, be limited or contained within the bounds of the heavens; or rather descends, and becomes communicated to the air and waters. But for the rotatory motion of projectiles, we refer it to the motion of liberty.

Let the eighteenth motion be the motion of trepidation, whereto, as it is understood by astronomers, we give no great credit. But we meet with this motion upon seriously searching into the appetites of natural bodies, and it seems proper to constitute it a species by itself. This motion is, as it were, a motion of eternal captivity; for, when bodies are not perfectly well placed, or situated, according to their natures, and yet are not in a perfectly bad state, they perpetually tremble, and prove restless, neither content with their present situation, nor daring to proceed farther.

This motion is found in the hearts and pulses of animals, and must necessarily reside in all bodies that remain in a doubtful state, between convenience and inconvenience, so as that when stretched or drawn, they try to free themselves, at which time they again suffer a repulsion, and yet are constantly trying.

Let the nineteenth and last motion be that which, though it scarcely answers to the name of a motion, is yet clearly of that kind, viz. the motion of indolence, or, as we may otherwise call it, the motion of dreading or resisting of motion.

By this motion it is that the earth stands firm in its own bulk, whilst the extremities thereof move themselves towards the middle, not to an imaginary centre, but to union. By this appetite, likewise, all bodies violently condensed have an aversion to motion, their sole appetite being not to move; and, although they should be instigated and incited to motion infinite ways, yet they obstinately preserve their own nature as far as possibly they can. But if they are compelled to move, they still constantly endeavour to regain rest, and recover their former state, so as, if possible, to move no more. And, in this case indeed, they become agile and swift; and, as if impatient of all delay, strive with velocity and rapidity to replace themselves. But we have only a partial image,

* Viz. Their elliptical motion.

or imperfect notion, of this appetite, because here with us no tangible bodies are condensed to the utmost, on account of the influence and agency of the celestial bodies upon them; and besides they also have some mixture of spirits.

And thus we have proposed the species, or simple elements of motions, appetites, and active virtues, which are most universal in nature, and under which much natural knowledge is contained. We deny not that other species may perhaps be added, that these divisions may be better adjusted to the true divisions or ramifications of things, and that they may be contracted in number: but we mean not this of any abstract divisions, as if any one should say, that bodies desired either the conservation, exaltation, propagation, fruition, of their own natures, or that the motion of things tends to the conservation and good, either of the universe, as the motions of resistance and connection, or of the larger universalities, as the motion of the greater congregation, rotation, and indolence, or of particular forms, as in all the rest; for, though this were true, yet it would be speculative, and of little use, unless it terminated in matter and structure, according to the true divisions or lines of nature.

In the mean time they will suffice, and be of good service in examining the predominancies of virtue, and searching out the instances of reluctance, which is the present business. For, of the motions here laid down, some are absolutely unconquerable, some are more prevailing than others, so as to bind, check, and dispose, those others; some dart themselves farther out than others, some again excel others in point of time and velocity, and, lastly, some cherish, strengthen, enlarge, and accelerate, others.

The motion of resistance is adamantine and invincible; but, whether the motion of connection be invincible or no, is a question; for we determine neither for nor against a vacuum, whether interspersed or collective, only conceive it plain, that the reason why a vacuum was introduced, by Leucippus and Democritus, (viz. because without it the same bodies could not possess and fill a greater or less space,) is ill founded, because matter may wrap and unwrap itself in space, within certain limits, without the interposition of vacuity. Nor has air two thousand times more vacuity than gold, as on that supposition it ought to have. And this appears sufficiently from the extremely powerful virtues of pneumatical bodies, (which must otherwise float like fine dust *in vacuo*,) and from many other proofs.*

But the other motions govern and obey each other, according to their proportions of strength, quantity, velocity, sphere of activity, and also according to the aids and impediments they meet with. For example, there are armed loadstones that will attract, and suspend, sixty times their own weight of iron, so much does the motion of the less congregation prevail over the motion of the larger; but this motion yields if the weight be greater. Leather extends to a certain degree, without breaking, and so far the motion of continuity over-rules the motion of tension; but if the tension be carried farther, the leather breaks, and the motion of continuation gives way. Water runs out at a crack of a certain size, in which case, the motion of the greater congregation prevails over the motion of continuity; but if the crack be smaller, the motion

* See the Author's History of Condensation and Rarifaction.

of the greater congregration gives way, and that of continuity prevails. If a musket be charged with sulphur, it will not throw out the ball, in which case, the motion of the greater congregation overcomes the motion of dilatation; but when the musket is charged with gunpowder, the motion of dilatation in the sulphur prevails, by the assistance of the motion of dilatation, and of the motion wherewith nitre flies from flame.—And the like is to be understood of the other cases. For the instances of reluctance, which indicate the predominancy of virtues, and the proportions wherein they conquer and yield, are on all sides to be sought out with great diligence.

So likewise the manner and proportions wherein motions give way are to be carefully examined, as whether they yield entirely, or rather resist to a degree, but are subdued; for in the bodies among us there is no such thing as true and perfect rest, neither in the wholes, nor in the parts, but only to appearance. And this apparent rest either proceeds from an equilibrium, or an absolute predominancy of motions; by an equilibrium, as in the balance, which rests on both sides, when the weights are equal; by predominancy, as in siphons, or perforated watering-pots, where the water rests, and is kept from falling through, by the prevalency of the motion of connection.

But as we said above, it must be observed, how far these yielding motions resist; for, if any person should be forcibly bound hand and foot, or otherwise detained, notwithstanding all the struggle he could make, his resistance is not the less because it does not prevail. And the state of this matter (viz. whether the yielding motion be, as it were, annihilated by the predominancy, or whether the resistance be continued, though latent, in the conflict) may perhaps appear from concurrency. For example, let trial be made in shooting, whether a musket, or cannon, fired at its utmost random, or point blank distance, throws a bullet more forcibly upwards, where the percussion is simple, or downwards where the motion of gravity concurs or conspires with the stroke.

Lastly, the canons, or rule of the predominancies, which occur, should be collected; as for example, that the more common the good which is desired, the stronger the motion; and that the motion of connection, which regards the communion of the universe, is stronger than the motion of gravity, which regards the communion of dense bodies; again, that the appetites of a private good do not generally prevail against the appetites of a more public good, unless in small quantities. And it were to be wished this also obtained in civil affairs.*

49. Among prerogative instances, we assign the twenty-fifth place to intimating instances; that is, such as hint, or point out, the advantages or conveniences of mankind; for, bare power and knowledge only enlarge, but do not enrich human nature, and therefore such things as principally appertain to the uses of life, are to be selected, or culled out from the general mass of things. The more proper place for speaking of these will be when we treat of reducing knowledge to practice.† But through the whole business of interpretation, we constantly, in every particular inquiry, or upon every subject, allot a place for the table of

* Here is an opening in that kind of Persian magic, which the Author has prosecuted farther on another occasion. Let the several kinds of motion, above laid down, be compared with those of Sir Isaac Newton, and the modern mathematical writers.

† A part not gone upon in the Novum Organum. See above, Aph. 21.

human uses, or the table of desiderata, wishes, or optatives;* for it is a part of knowledge to inquire, and even to wish discreetly.

50. In the twenty-sixth place, among prerogative instances, come sovereign or general instances; that is, such as regard a variety of particulars and occur frequently, whence they greatly save trouble and prevent the search after new demonstations; but, for the instruments themselves and the particular managements, the more proper place to treat of them is, when we come to the ways of practice, and the method of experimenting,† for the things hitherto known and used, in the exercise of all particular arts, must be described. But at present we will subjoin a few generals with regard thereto, in the way of exemplifying these sovereign instances.

Man, therefore, (besides the business of simply putting bodies together and taking them asunder,) operates upon natural bodies seven principal ways, viz. 1, by excluding such things as might hinder or disturb the process; 2, by compressing, extending, agitating, and the like; 3, by heat or cold; 4, by continuing the matters in a convenient place; 5, by the moderating and governing of motion; 6, by particular consents; 7, by a seasonable and due change, alteration, or series and succession, of all the preceding ways, or at least some of them.

With regard to the first means of practice, viz. by excluding such things as might hinder or disturb the process, the common air, which is every where at hand, insinuating itself, and the rays of the celestial bodies, cause great disturbance; and therefore such things as exclude them may deservedly be accounted sovereign. — And to this belong the matter and strength or thickness of the vessels, wherein the subject, or bodies prepared for the operation, are included, as also the exact methods of closing up these vessels, with proper and strong materials, or with philosophical luting, as the chemists call it. So likewise the closing of vessels by means of liquors applied on the outside, is a very useful thing, as, when they pour oil upon wine, or other vegetable juices; for, the oil floating on the top, like a stopple, excellently preserves them from the injury of the air. Nor are powders unfit for this purpose, which, though they contain a mixture of air, yet expel and prevent the force of the external air, as we see in the preserving of grapes and other fruits, by sand or flour. So again, wax, honey, pitch, and the like tenacious bodies, are properly used with a view to close vessels perfectly, and exclude the external air or atmosphere. And we have sometimes buried vessels and other bodies in quicksilver, the densest fluid that can be employed for this purpose.

Pits, caves, and subterraneous receptacles, are likewise of great use to exclude the sun, and the open air, which prey upon things. And these kinds of caves are used in the northern part of Germany for granaries. And to this head belongs also the suffering of bodies to lie at the bottom of water. Thus I remember to have heard that certain bottles of wine, let down to cool in a well, being by a casual neglect left there and forgotten for many years, but at length drawn up again, the wine was found to be grown, not vapid or flat, but much more gene-

* See the close of the History of Winds, and Condensation and Rarifaction.

† See the Sylva Sylvarum throughout. See also the De Augment. Scientiarum, Sect. 12.

rous and noble.* But if it should be required to sink bodies to the bottom of a river or the sea, without their touching the water, or without being included in stopped vessels, and yet be surrounded by air, the diving-bell, which is a vessel sometimes employed in working upon wrecks or ships under water, may here prove of good service.

This vessel is made of metal, hollow like a cask, and, being let down with its bottom parallel to the surface of the water, it carries along with it all the air it contains to the bottom of the sea:† and, having three feet to stand upon, somewhat short of the height of a man, the diver, when he wants to breathe, conveys his head into the cavity of the vessel, where, being refreshed with air, he afterwards continues his work. And we have heard that a boat, or small ship, was lately contrived, wherein men may row under water, for some distance.‡ However this may be, under such a vessel as we just now described, bodies may be easily suspended in air, at the bottom of the sea.

There is also another use of carefully including and shutting up bodies in vessels, viz. not only to keep out the external air, but also to keep in the spirit of the body operated upon internally, for it is necessary the operator upon natural bodies should be certain of his quantities, or that nothing should expire or go off; for it is then that deep or great alterations are made in bodies, when, as nature prohibits annihilation, art also prevents loss or the escape of any part of the subject. But a false notion has here prevailed, which, if it were true, the preservation of the entire quantity of a body, without diminution, might be in a manner despaired of. The notion is this, that the spirits of bodies and air highly rarified by heat can be contained by no vessels, but constantly escapes through their pores.—Men have been persuaded to this opinion by those common experiments, 1. of inverting a glass, with a piece of lighted paper or candle in it, into water, whence the water rises upwards; and, 2, of cupping-glasses, which being heated with flame, attract the flesh; for men have imagined, in both cases, that the air is attenuated, discharged, and lessened in quantity, whence the water or flesh succeeds by the motion of connection.

But this is erroneous, for the air is not here lessened in quantity, but contracted in space; nor does the water rise before the flame is extinguished, or the air grown cold; insomuch, that physicians, to make the cupping-glases draw the better, clap sponges upon them, dipt in cold water.‖ Therefore men need not be so apprehensive that air or spirits should easily escape this way; for, though it be true that the most solid bodies have their pores, yet air or spirit will not easily be subtilized to such a degree, as neither will water pass through a very small crack.

* See the article Maturation, in the Sylva Sylvarum.

† See Dr. Hailey's account of the diving-bell, in the Philosophical Transactions, No. 349.

‡ An invention of this kind is usually attributed to Cornelius Drebbel, who is said to have had a volatile liquor for restoring the air to its pristine temper, after having been spoiled by respiration. It is farther said, that this effect was produced barely by unstopping the glass, wherein the liquor was contained. But of this matter there seems to be nothing known with certainty, or at best not with the requisite particularity.

‖ The later manner of explaining this phenomenon by the rarifaction of the internal air, and the pressure of the external, will not here alter the case, because the air, upon this supposition, does not pass through the glass.

As to the second means of practice, viz. by compressing, extending, agitating, &c. it is principally to be observed, that compressions and such kinds of violence are of very great force in local motions, and the like, as in machines and projectiles, even so as to destroy organical bodies, and their virtues or powers, which plainly consist in motion; for, as all life, all flame and ignition, are destroyed by compression, so is every machine spoiled and its parts confounded or destroyed by the same. They are also of force to destroy the virtues consisting in arrangement or position, and a somewhat grosser dissimilarity of parts, as in colours, for the colour of a flower, when whole, differs from its colour when bruised; and so the colour of amber, when whole, differs from the colour of amber, when bruised. So again with regard to taste, the taste of an unripe fruit is not the same as when ripe, or after having been squeezed and pressed, but manifestly sweeter. These violences, however, have no great power over the more noble transformations and alterations of similar bodies, because bodies, by their means, do not acquire any new, permanent, and quiescent state, but one that is transitory and always endeavouring to restore and free itself.

But it might be proper to make some careful experiments to shew, whether the condensation of a similar body, as water, oil, &c.* or a rarifaction violently introduced, may become constant and fixed, so as to change, as it were, the nature of the subject, and it should first be tried by bare continuance and afterwards by helps and consents. This would be easier to do in the experiment formerly mentioned for attempting the condensation of water, included in a lead vessel, and wrought by the hammer and the press,† in which case the metalline globe, when beat flat, should be left in that state for some days before the water was taken out, in order to see whether it would immediately fill the same dimensions it had before the operation; for, if it did not, either immediately or soon after, the condensation might seem to have been permanent; or, otherwise, if the water restored itself, the compression would appear to have been only transitory.

And something of the same kind might be tried, as to the extension and rarifaction of the air, in glass-eggs, after the manner formerly mentioned,‡ when the air, being strongly extracted by suction out of the glasses, and the orifices suddenly closed and well secured, the glasses are to remain thus for some days, and afterwards to be opened, to see whether the external air would be attracted with a hissing noise in at the orifices of the glasses; or if, being opened under water, the same quantity of water would be drawn in, as if they had been directly plunged into water at first, after the air was sucked out.

It is probable (or at least deserves to be proved) that such condensations and rarifactions may be made; because continuance of time has the like effect in bodies a little more dissimilar; thus, for example, a stick being bent by compression for some time, does not come straight again. And this cannot be attributed to any loss in the quantity of the wood by the continuance, because the same thing happens also in a plate of

* See an experiment of this kind performed upon air, in Mr. Hauksbee's Physico-Mechanical Experiments, p. 162–166.

† See Aph. 43.

‡ See Aph. 43.

iron, which is not exhalable. But, though the experiment should not succeed by bare continuance, still the business is not to be deserted, but other assistances used;* for it is no small acquisition, if fixed and constant natures may be given to bodies by violence; for thus air might be converted into water by condensation, and many things of the like kind be performable, for man has a greater command over violent motions than he has over the rest.†

The third means of practice regards that grand engine, or instrument, both of nature and art, viz. heat and cold. And here the human power seems perfectly lame on one side, for we have the heat of fire infinitely stronger, or more intense, than that of the sun, as it naturally comes to us, or than the heat of animals; but cold is wanting, unless so far as it may be procured by the severity of winter, by caverns, or by the application of snow and ice, which in the way of comparison may about equal the degree of heat afforded by the noon-day sun in some parts of the torrid zone, increased by the reverberations of mountains and walls, for such a degree of heat and cold may, for a small time, be endured by animals; but this is nothing to the heat of a melting-furnace, or to a degree of cold that answers to such a degree of heat. And therefore all things with us tend but to rarifaction, desication, and consumption, and scarcely any to condensation and intenebration or suppleness, unless by mixture, and, as it were, by spurious means. Wherefore instances of cold are with great diligence to be sought after, such as may, perhaps, be found by exposing bodies at great heights, in sharp frosts, laying them in subterraneal caves, surrounding them with snow and ice in deep places or reservatories made for the purpose, by letting bodies down into wells, burying them in quicksilver and metals, plunging them in the waters which petrify wood,‡ burying them in the ground, (as they relate of the matter for making porcelain,) and the like. So likewise the condensations naturally made by cold are to be sought, that their causes being discovered, such condensations may be transferred into arts. Such natural condensations we see in the sweating of marble and stone; in the dew condensed on the inside of glass windows after a frosty night; in the condensation of vapours into water within the earth, whence springs frequently arise; and other examples of this kind.

But beside those things which are cold to the touch, there are certain others potentially cold, which also condense, though they seem to operate only upon animal bodies, and scarcely upon others. — And of this kind are many things in medicine, for some remedies condense the flesh and tangible parts, such as astringents and thickeners; and others condense the spirits, as appears chiefly in narcotics.‖

* Such as large and strong condensing vessels and syringes, for compressing and confining the air.

† The experiments of this kind seem to have been no way duly prosecuted.—The success which Mr. Hauksbee met with, in a slight attempt to destroy the spring of common air, might very well encourage the use of greater violence, stronger vessels, and a greater length of time for the purpose. — See his Physico-Mechanical Experiments, p. 162, &c.

‡ For producing the greatest degreee of artificial cold, by freezing mixtures, see Mr. Boyle's History of Cold, and the Chapter of Fire, in Dr. Boerhaave's Chemistry.

‖ See the History of Life and Death.

There are two ways of condensing the spirits by soporiferous medicines, the one by appeasing the motion of the spirits, and the other by dispelling or putting them to flight. Thus violets, roses, lettuces, and the like mild and gentle vapours, invite spirits to unite and restrain their brisk and restless motion, but the stronger opiates, by a malignant and unfriendly quality, put the spirits to flight; and, therefore, if these are applied externally, the spirits presently retire from the part, and willingly enter into it no longer; but, if taken internally, their fumes ascending to the head, every way chase away the spirits contained in the ventricles of the brain; and, when the spirits thus retreat, and are unable to fly into any other part, they consequently come together, and are thus condensed, or sometimes quite extinguished or suffocated; though the same opiates taken in moderation have the virtue, by a secondary accident, (or by that condensation which succeeds upon the coming together of the spirits,) of supporting and fortifying the spirits, and checking their useless and incentive motions, whence such opiates become of good service in the cure of diseases and the prolonging of life.*

The preparations of bodies, likewise, for the admission or reception of cold, cannot be admitted. Thus it is thought that a little warming of water hastens its freezing by cold, more than if the water was not warmed at all. And the instances of this kind are to be collected.†

But as nature supplies cold so sparingly, we should here imitate the apothecaries, (who, when a simple cannot be procured, substitute one thing for another,) and carefully search out the substitutes or succedaneums for cold; that is, we should inquire how condensations may be made in bodies without cold, whose proper office it is to effect them.

And these condensations seem to be of four kinds, the first whereof depends the bare contrusion, which, because of the resistance or recoiling of bodies, has but little force in causing a permanent density, though it may do somewhat as an auxiliary. — The second is made by the contraction of the grosser parts of a body after the avolation or exit of the finer, as happens in indurations by the fire, and the repeated quenching of metals, &c. The third is made by the approach or coming together of the more solid or ponderous homogenous parts of a body, which before were separated and mixed among the less solid, as, in recovering the quicksilver from mercury-sublimate, which in powder possesses much more space than simple mercury; and so again, in purging and separating of metals from their dross. The fourth is made by consent, or applying such things as condense by a secret virtue in bodies, though these consents have hitherto seldom appeared, which is no wonder, because, till some progress is made in the discovery of the forms and structures of things there can be but slender hopes of advantage arising from the inquiry into the consents of bodies.‡

But with regard to the bodies of animals, there are doubtless many remedies, both internal and external, which condense, as it were, by

* See the History of Life and Death.

† See Mr. Boyle's History of Cold.

‡ Because such consents, or particular agreements, depend thereon.

consent, according to what was just now observed; but this kind of operation is rare in inanimate bodies.* There goes a report, as well in writing as discourse, of a tree in one of the Tercera Islands, that perpetually distils water, so as to be of some convenience to the inhabitants:† and Paracelsus says, there is a plant called Rosa Solis, or Ross Solis, that remains full of dew in the noon-day heat, when all other herbs are dry.‡ And if these instances are true, they might prove of noble use, and very worthy of farther examination. But for those honey-dews, which, like manna, are found upon oak-leaves in the month of May; we judge they are not made or condensed by any consent or peculiarity in the oak-leaf, but that they fall upon other leaves also, and are only catched and detained upon the leaves of the oak, because these are closer, and not so spongy as most other leaves.

As to heat, men have a large supply, and a great command thereof, though some of its most necessary particulars still remain to be observed and inquired into, notwithstanding the boasts of the chemists. For though the works of intense heat are much sought after and admired, yet the effects of a slow heat (which are chiefly those produced by nature) remain unexperienced and concealed. Hence we see by the violent heats now commonly used, the spirits of bodies are greatly exalted, as in mineral acid spirits, and certain chemical oils, but the tangible parts are hardened, and sometimes fixed, with the loss of the volatile ones.—And thus the homogeneous parts are separated, and the heterogeneous grossly incorporated and mixed together, whilst the structure and more subtile texture of compound bodies is by this means confounded and destroyed, so that the effects of a milder heat ought, by all means, to be tried and discovered; whence much more subtile mixtures and regular textures, or structures of bodies, might be procured in imitation of nature and the works of the sun, according to what we intimated above.‖ For the operations of nature are performed by much slower degrees, or much smaller steps and portions at a time, and by more exquisite and various positions or arrangements, than the works of fire, as it is now employed. And it is then that the human power may seem truly enlarged, when, by heats and artificial ways, the works of nature may be exactly imitated, or expressed in appearance, perfected in virtue, and varied in number; to which we may also add, accelerated in time.§ Thus the rust of iron is a long while in making, but expeditiously obtained in the artificial Crocus Martis. And the same is to be understood of verdigrease and ceruse. Crystal is produced by a long process, but glass by a short one; stones grow slow, but bricks are presently made.

And all the diversities of heat, with their different effects, are, with diligence and industry, to be sought out and collected from all quarters, viz. (1.) those of the heavenly bodies, by their direct rays; and as they

* See the History of Condensation and Rarifaction.

† See Dr. Sprat's History of the Royal Society.

‡ See the Sylva Sylvarum.

‖ See Aph. 35.

§ See the Sylva Sylvarum.

are reflected, refracted, and united by burning-glasses:* (2.) those of lightning, flame, and coal-fires: (3.) Fires of different material: (4.) open fires, close fires, straitened and streaming fires, or fires modified by all the various structures of furnaces: (5.) Fire animated by the blast: (6.) Fire left to itself, unexcited: (7.) Fire removed to a greater or less distance: (8.) Fire acting through different mediums: (9.) moist heats, as those of the Balneum Mariæ, and the dunghill; external and internal animal heats; compressed hay, &c. (10.) dry heats, as of ashes, lime, sand; and, in short, heats of all kinds, with their various degrees.†

Above all, the inquiry and discovery of the effects and productions of heat, continued and remitted gradually, regularly, and periodically, at due distances, and with due continuance, should be attempted; for this stated inequality is a true offspring of the heavens, and the mother of generation. Nor is any thing extremely great and commanding to be expected from a vehement, hasty, and subsultory heat. This appears plainly in vegetables; and again in the wombs of animals, where there is a great inequality of heat, from the motion, the sleep, the food, and the passions of the female in gestation; and, lastly, the same inequality takes place in the matrices of the earth, where metals and minerals are formed.

This renders the unskilfulness of some modern alchemists the more remarkable, who expect to obtain their end by means of an athanor, or the equable heats of lamps, &c. kept burning in one constant manner.‡ And so much, at present, for the works and effects of heat. Nor is it yet the season to examine these particulars thoroughly, before the forms and textures of bodies shall have been farther discovered and brought to light, for it is then that instruments are to be sought out, applied, and adapted, when the examples, views, and designs, are fixed and determined.

The fourth means of practice, viz. continuance, is the provider and dispenser of nature. We call that continuance, when a body is left for a considerable time to itself, guarded and defended from all external force, in which state the intestine motions discover, and finish, or perfect their own course, whilst the extraneous and adventitious motions are excluded, for the works of time are much more subtile than the works of fire.‖ Wine can no way be so well clarified by the fire, as by time, nor are the incinerations made by fire so exquisite as the resolutions, consumptions, and decays of time. The sudden and precipitate incorporations and mixtures made by fire are far inferior to those made by time. And the different and various textures, which bodies endeavour at by continuance, as in the case of putrefactions, are destroyed by fire, or a violent heat.§

It may be here proper to observe, that the motions of bodies perfectly included, or close confined in vessels, suffer something of violence, as

* See the Experiments made with the Duke of Orleans's burning lens, by M. Homberg.—Memoir. de l'Acad. Roy. An. 1702.——See also the Philosophical Transactions and German Ephemerides to the same purpose.

† See the New Atlantis, in a collection of the Author's Miscellaneous Writings.

‡ See the Sylva Sylvarum under the article Gold.

‖ See the Sylva Sylvarum, under the Articles Heat, Preservation, and Putrefaction.

§ See the Sylva Sylvarum.

this imprisonment hinders the spontaneous motions of the body, and therefore continuance in an open vessel conduces more to separation; but in a vessel perfectly closed, to commixture, or combination, and in a vessel imperfectly closed without excluding the air, to putrefaction;* and in all these cases, instances of the works and effects of continuance are to be diligently collected from all quarters.

The fifth means of operating, viz. by government and regulation of motion, is extremely powerful. We call that the government and regulation of motion, when one body, by meeting another, hinders, repels, or directs, its spontaneous motion. And this generally consists in the figure and position, or situation of the vessels; thus the figure of an erect cone forwards the condensation of vapours, in alembics, but an inverted cone promotes the purging of sugar, or the discharge of the treacle into the receivers.† Sometimes also curvature, or flexure, straitness, and dilatation, are required by turns, and the like. And all percolation depends upon this, that whilst the opposing body opens to one part of the liquor, it closes upon or stops another.‡ Nor is the business of percolation, or other regulation of motion, always carried on by external means, but also by internal, or by means of one body within another, as when stones are put into water to collect its sediment, or earthy parts, or when syrups are clarified with the white of eggs, whereto the grosser fæculences adhere, and may be afterwards separated. And to this regulation and direction of motion, Telesius, from a slight and superficial consideration, attributes the figures of animals, as if they were moulded, and took the impression of the veiny, wrinkled, and hollowed sides of the matrix. For he ought to have considered, that though eggs also are formed in the uterus, after the same manner as the fœtus, yet no wrinkles or inequalities appear on their shells. But it is true, indeed, that the regulation of motion produces figure in moulding and cast-work.

The sixth means of practice consists in operating by consents, or avoidances, which frequently lie deep concealed; for those usually called occult and specific properties, and sympathies and antipathies, are in great measure the corruptions of philosophy. Nor can we have any solid hopes of discovering the consents of things, before the discovery of forms and simple textures, for consent is no more than the sympathy or correspondence of forms and textures to each other.

But the greater and more universal consents of things are not absolutely obscure. We will therefore begin with these. The first and principal diversity of things is this, that some bodies differ greatly in their quantity and rarity of matter, yet agree in texture; whilst others agree in quantity and rarity of matter, but differ in texture. For it is well observed, that the two chemical principles, sulphur and mercury, run, as it were, through the universe of things.‖ And, doubtless, there appears to be a certain consent of nature, or an agreement of bodies, in these two principles, from a consideration of the most universal phœnomena. Thus there is an agreement betwixt brimstone, oil,

* See the article Putrefaction, in the Sylva Sylvarum.

† And hence the figures or make of all the chemical or other vessels may be easily determined See Boerhaave's Chemistry, under the chapter of Vessels.

‡ See the articles Clarification and Percolation, in the Sylva Sylvarum.

‖ See the Sylva Sylvarum, under the article Principles of Chemistry.

unctuous exhalations, flame, and perhaps the body of the stars; and again, between quicksilver, water, and aqueous vapours, air, and perhaps the pure interstellar æther. But these two larger sets, or tribes of things, differ prodigiously from each other in quantity of matter and density, though they greatly agree in texture, as appears in numerous instances. But, on the other hand, the different metals have a great agreement in quantity of matter and density, especially in respect of vegetables, &c. but differ greatly in texture, whilst vegetables and animals have an infinite variety of texture, yet differ not considerably in quantity of matter or density.*

The next most general consent is that betwixt primary or perfect bodies, and their fostering matters, that is, their solvents and aliments. It must, therefore, be examined, in what climate, in what earth, or glebe, and at what depth, all the metals are generated;† and so of gems, whether those of the rock, or produced in mines:‡ in what glebe, or earth, all trees, shrubs, and plants, principally grow and delight; likewise what amendments, or kinds of composts, whether of chalk, sea-sand, ashes, &c. succeed the best; and which of them are fittest and most serviceable, according to the difference of the land.—So again, the grafting and inoculating of trees and plants, with the methods thereof, for the most successful ingrafting has a great dependance upon consent, betwixt the trees ingrafted. In which respect, it is an agreeable experiment, which we are informed was lately tried, of the ingrafting of field-trees, which has hitherto been practised only in those of the garden: whence the leaves and mast of the former have been obtained much larger and the trees rendered more shady.‖ In like manner, the aliments of animals must be respectively noted in general, together with their negatives,§ for carniverous animals cannot be fed with herbage. Whence (though the will in men has a greater influence over their bodies than in other animals) the order of the folietani, or leaf-eaters, is said to have dropped, after trial, upon finding that leaves were not capable of nourishing the human body.** Again, the different matters of putrefactions, whence little living creatures are bred, should be likewise regarded.††

The consents betwixt perfect bodies and their subordinates, as exemplified above, are sufficiently manifest, whereto may be added the consents betwixt the senses and their objects. And as these latter consents are exceedingly evident, well observed, and thoroughly discussed, they may afford great light to other consents that are hitherto latent.‡‡

But the internal consents and avoidances of bodies, or their affections, vulgarly and often superstitiously called by the name of sympathies and antipathies, (whence we unwillingly use the expression,) are

* See the History of Condensation and Rarifaction.

† See Becher's Physica Subterranea.

‡ See Mr. Boyle's piece of the Origin and Virtues of Gems.

‖ See the Sylva Sylvarum, under the article Vegetable and Vegetation.

§ As in discovering the form of heat.—See the Tables, Aph. 12, &c.

** See the Sylva Sylvarum. †† Ibid.

‡‡ See the Sylva Sylvarum, under the articles Imagination, Senses, Sound, Sympathy, &c.

exceedingly rare, as being either falsely attributed to things, mixed with fables, or overlooked and neglected. Thus there is said to be an enmity between the vine and colewort, because they thrive not well when planted near each other; whereas the reason is, that both of them are succulent, and powerfully attract the moisture of the earth, whence they mutually defraud each other. So there is said to be a consent and friendship betwixt corn and the red poppy, because they both grow only in ploughed ground, whereas there rather seems to be an enmity between them, because the poppy grows from such a juice of the earth as was left and rejected by the corn, so that the sowing of corn prepares the ground to yield poppies. And there is a great number of these false reasons and fictitious solutions of consents or sympathies prevailing. But fables are here to be absolutely rejected, whence there will remain but a slender stock of such consents as are approved by certain experience, like those between iron and the loadstone, gold and quicksilver, &c. though there are some others also found worthy of observation in chemical experiments upon metals.*— But the most are to be observed in certain medicines, which, by secret and specific properties, regard either certain parts or humours of the body, or certain diseases, and sometimes individual natures.†

Nor are the consents between the motions and changes of the moon, and the affections and passions of the inferior bodies, to be omitted; so far as they may be observed, and collected, from the experiments of agriculture, navigation, and medicine, or otherwise, with the requisite severity, and justness of choice and judgment.‡ And the less common all the instances of secret consents are, with the greatest diligence they ought to be inquired into, upon the footing of faithful history and just relation; provided this be done without levity, or credulity, and with a proper degree of doubt, suspension, and tradition.‖

There is still another consent of bodies in the way of operating, which, though it seems inartificial, is yet of excellent and various use, and ought, therefore, to be inquired into by the means of careful observation, viz. a disposition, or indisposition, to unite by simple composition, or apposition; for some bodies easily and readily mix and incorporate, but others with difficulty, and unwillingly. Thus powders mix best with waters, but calxes and ashes with oils, &c. And not only the instances of the propensity or averseness of bodies to mix are to be collected, but likewise the instances of the arrangement of parts, their distribution and digestion upon mixture, and, lastly, those of predominancy after the union is made.§

The seventh and last method, or means of practice, is to operate by changing and variously combining the former six. But, till each of those shall have been farther inquired into, it will not be seasonable to offer any examples of this method. The series, or chain, of this kind of alternation or different combination of ways, as it may be accom-

* See Becher's Physica Subterranea.

† See Mr. Boyle of Specific Remedies.

‡ See the Sylva Sylvarum and History of Winds.

‖ See Sylva Sylvarum, under the articles Imagination, Sympathy, &c.

§ It deserves to be attentively considered how ready and commodious a thing practice would prove, if all the assistances here pointed out were procured, and employed as they might be, according to the design of this piece.

modated to the production of particular effects, is, indeed, exceedingly difficult to be understood, though extremely powerful in the effecting of works. But mankind labour under the utmost impatience with regard to this kind of inquiry and practice,* though it be like a clue to the labyrinth of great works ;† and thus much by the way of illustrating sovereign instances.

51. In the twenty-seventh and last place, among our prerogative instances, come magical instances, by which we understand such wherein the matter, or efficient, is but small, compared with the greatness of the work, or effect produced, so that, though these instances were common, they would still be almost miraculous, some of them at first sight, and others even when attentively considered. Nature, indeed, of herself affords these sparingly; but what she may do when farther searched and entered into, and after the discovery of forms, latent processes, and concealed structures, will appear to posterity.‡

These magical effects, so far as we can hitherto conjecture, are produced three ways, viz. (1.) by self-multiplication, as in fire, and those poisons called specific, as also in motions, which pass and increase as they go from wheel to wheel; (2.) by excitation or invitation in another body, as the loadstone animates numberless needles, without loss or diminution of its virtue; and we find the same kind of virtue in yeast, &c.; (3.) by the pre-occupation of motion, as we above observed in gunpowder, guns, and mines.‖

The two former of these methods require the discovery of consents, and the third the measure of motions. But, whether there be any method of changing bodies in their smallest parts, and transposing the more subtile textures, or structures, of matters, (which is a thing that regards all kinds of transformations in bodies,) so that art might thus quickly effect what nature is a long while bringing about, we have hitherto no certain indications; for, as in things that are solid, true, and useful, we aspire to the ultimate or highest perfection, so we perpetually despise, and to the utmost of our power discard and reject, such as are vain, tumid, and empty. And so much for the subject of prerogative instances.

52. It must be observed, that in this our new machine for the understanding, we deliver a logic, not a philosophy; but, as our logic directs the understanding and instructs it, not like the common logic, to catch and lay hold of abstracted notions, as it were by the slender twigs or tendrils of the mind, but really enters and cuts through nature, and discovers the virtues and actions of bodies, together with their laws, as determined in matter, so that this knowledge flows not

* That is, they have not patience to go through the inquiry, which alone directly leads up to practice, or they preposterously desire to obtain the end without enduring the means.

† The reader may have some tolerable notion of the thing here meant, by carefully reading over the Author's Histories of Life and Death, of Winds, and of Condensation and Rarifaction, and understanding to what discoveries they lead, or what the tendency is of the whole.

‡ Little progress has been hitherto made in this medullary part of physics; for men have frequently mistaken or wilfully deserted the road that leads to it, though this was not only pointed out, but entered by the Author, as appears remarkably in his Sylva Sylvarum, History of Life and Death, History of Winds, &c.

‖ Aph. 36.

from the nature of things and the universe; hence it is no wonder, that, in order to give examples and illustrations of our art, we every where employ physical considerations and experiments.

We have here laid down twenty-seven prerogative instances, viz. 1, solitary instances; 2, travelling instances; 3, glaring instances; 4, clandestine instances; 5, constituent instances; 6, conformable instances; 7, singular instances; 8, deviating instances; 9, frontier instances; 10, instances of power; 11, accompanying and hostile instances; 12, subjunctive instances; 13, instances of alliance; 14, crucial instances; 15, instances of divorce; 16, instances of entrance; 17, summoning instances; 18, journeying instances; 19, supplemental instances; 20, lancing instances; 21, instances of the staff; 22, instances of the course; 23, doses of nature; 24, instances of reluctance; 25, intimating instances; 26, sovereign instances; and, 27, magical instances. And, in point of information, they assist either the sense, or the understanding; the sense as the five instances of light; and the understanding, either by hastening the exclusion of the form,* as the solitary instances, or by contracting and more nearly indicating the affirmative of the form,† as the travelling, glaring, accompanying, and subjunctive instances; or by raising the understanding and leading it to kinds and common natures, and that either immediately, as the clandestine and the singular instances, and instances of alliance; or in the next degree, as the constituent instances; or in the lowest degree, as the conformable instances; or again, by rectifying the understanding, depraved by the things whereto it is accustomed, as the deviating instances; or by conducting it to the great form or fabric of the universe, as the frontier instances; or, lastly, by guarding it against false forms and causes, as the crucial instances, and instances of divorce.

And as to practice, they either mark out, measure, or facilitate it.—They mark it out by shewing with what particulars we are to begin, to prevent labouring in vain; as the instances of power, or to what we should aspire, if it be attainable, as the intimating instances; the four mathematical ones measure and limit it, and the sovereign and magical ones facilitate it.‡

And of these twenty-seven instances, a collection of some should be made at first, as was above observed,‖ without waiting till we come to

* See the Tables, Aph. 11, 12, &c.

† See the Tables, Aph. 11, &c.

‡ If all this has not been clearly perceived in reading the foregoing Doctrine of Prerogative Instances, the whole may deserve to be read over again, in the light that is here afforded. And, as a foundation, let the fourth Aphorism of this Second Part be well understood. When the whole is conquered, it will appear that this Doctrine of Instances is a very important part of the Novum Organum, and makes the business of inquiry an almost mechanical thing, level to every capacity; for, if the Instances, that is, particulars, be collected upon any subject, and thrown into Tables in the manner here directed, they of themselves exhibit a concise history of the subject that leads up to its form or latent process. Hence this Doctrine of Instances is a kind of general Direction or Table for the due conducting and prosecuting of all inquiries, so as at the same time to determine, limit, or almost grasp, the form of the nature inquired into and lead directly to practice. And in this view let the Author's particular Histories be constantly read; as those of Life and Death, Winds, Condensation and Rarifaction, and several in the Sylvatum.

‖ See Aph. 37.

particular inquiries: and of this kind are the conformable, the singular, the deviating, and the frontier instances; the instances of power, of entrance, intimating, sovereign, and magical instances; because these either assist and rectify the understanding or the sense, or afford instruction with regard to practice in general; and for the rest they are to be searched out when we make tables of view* for the business of the interpreter on any particular subject. For, the instances honoured and ennobled with these prerogatives are like a soul among vulgar instances of view; and, as we said at the first,† a few of them serve instead of many; and, therefore, when we make tables, such instances are studiously to be sought out, and set down therein. The doctrine of them was also necessary to what we design shall follow: and therefore a preparatory account thereof was here requisite.

And now we should proceed to the helps and rectification of induction, then to concretes, latent processes, concealed structures, &c. as mentioned in order, under the twenty-first aphorism; that at length, like faithful guardians, we might possess mankind of their fortunes, and release and free the understanding from its minority, upon which an amendment of the state and condition of mankind and an enlargement of their power over nature must necessarily ensue; for, by the fall, man at once forfeited his innocency, and his dominion over the creatures, though both of them are, in some measure, recoverable, even in this life, the former by religion and faith, and the latter by arts and sciences. For the world was not made absolutely rebellious by the curse, but in virtue of that denunciation, "In the sweat of thy brow, thou shalt eat thy bread," it is at length, not by disputes or indolent magical ceremonies,‡ but by various real labours, subdued, and brought in some degree to afford the necessaries of life.

* See Aph. 11, &c. † See Aph. 22.

‡ Such as those in the Sympathetic Philosophy, the Magical Philosophy of Paracelsus, &c.

APPENDIX.

The author purposely left many parts of his new engine untouched, to go in quest of proper materials whereon to employ it; and, being prevented by death, did not return from prosecuting the latter design, to finish the former. Whence though the parts that are treated, appear perfect, as parts; yet the whole of this grand engine wants much of being completed.

The contrivance itself has, by the greatest masters in science, been thought the best adapted, and most serviceable, of all those at any time proposed, for the advancement of philosophy and art; so that to perfect and fit it for general use may deserve more than ordinary care and concern.

And though to bring it so forward as we find it, was the labour of a master-builder; though the work, in its own nature, is difficult, and, to vulgar philosophers, somewhat paradoxical; yet, perhaps, the author has left such instructions concerning it, as may enable workmen of a lower class to finish it, and render the method of using it generally intelligible: which seems rather to require sedulous application than any extraordinary learning, or uncommon abilities.

In order, therefore, to promote the finishing thereof, it may be proper to indicate the more considerable attempts that have hitherto been made, with a view to something of the kind; and shew what farther remains to be done, with regard to the perfecting of this noble invention, and bringing it into familiar use.

Aristotle has left us four books of analytics: the two first whereof shew how to construct the forms of reasoning, and the two latter deliver the art of discovering and judging of things.

These books of analytics appear to have been little understood, till they were illustrated and explained by Gunther: with the addition of what is found to the same purpose in Plato* and Galen.† Gunther has two treatises upon the subject: whence many latter writers upon methods seem to have drawn their doctrine; only illustrating it with examples derived from mathematics, algebra, and physics.‡

This work of Gunther was many years after succeeded by another of the great mathematician Weigelius; wherein he endeavours to deduce the art of demonstration from mathematical principles; and farther to explain, illustrate, and shew the use of, Aristotle's analytics.‖

The celebrated M. Des Cartes wrote an express treatise De Methodo; wherein he reduces the whole art to four rules, that seem contained in

* See Plato, in Phædr.

† See Galen. de optim. Docend. gen.

‡ See Owenus Guntherus Methodorum Tractatus duo, continentes totius artis Logicæ medullam, facultatem omnium Scientiarum ac Demonstrationum Principia inveniendi, dijudicandique rationem. Helmstad. 1586.

‖ See Analysis Aristotelica, ex Euclide restituta. Jenæ, 1658.

Aristotle's analytics; and will be found to coincide with the Medicina Méntis, mentioned below. This method of Des Cartes is delivered, with considerable improvements, in the fourth part of the Art de Penser; where the author constitutes to method; viz. the analytical, and synthetical; the former discovering, and the latter for teaching. And he illustrates the whole with a variety of examples, as well physical as mathematical.

Upon the same foundation, in the year 1687, the excellent M. Tschirnhaus, a Member of the Royal Academy of Sciences at Paris, published an Essay towards a genuine logic of method of discovering unknown truths * This is an extraordinary performance, that proceeds entirely upon the mathematical or rather algebraical method, and deserves to be read with care and attention.

M. Tschirnhaus, reflecting that mathematicians being the only set of men, who either maintained no controversies, or at least soon came to a determination of them; hence apprehended that mathematicians alone were possessed of the right method of inquiry. Upon this, he applied himself to mathematical studies, in order to see whether, by making the proper alterations, the mathematical method could not also be accommodated to other subjects.

In particular, he applied himself to algebra, and found that this art performs even more than it promises, and with the highest degree of certainty; when, having acquired a habit of solving the greatest difficulties therein, and examining the secret nature of its method or manner of procedure, he says, he observed that unknown truths may be discovered, after the same manner, not only in mathematics, but in every other science.

He makes the foundation of human certainty to lie in those things wherein the operation of the understanding is most manifest, or those which may be conceived, without any possibility of a contradiction; as that the whole is greater than a part, that the radii of a circle are equal, &c. whence numerous other truths may be drawn; and, on the other hand, he lays it down for certain, that those things which cannot be conceived are false.

But here the Author cautions us against being deceived by the imagination; for, according to him, many things are perceived by the imagination only, of which things no distinct notion or conception can by words be communicated to another, as in the case of pain, light, colour, sound, &c. Hence he recommends two ways of distinguishing between the perceptions of the imagination and the conceptions of the understanding. The first is, by large and frequent experience, and especially by the help of mathematics, to acquire a habit of finding the difference betwixt them, and the second is to consider the equality there is in the human understanding, which all men have equally alike, for what a man truly conceives he can communicate to another, as we see in mathematical demonstrations, which are equally understood by all men; whereas those things which are perceived by the imagination, as he calls it, are perceived unequally, or more by some and less by others; and, by justly distinguishing betwixt these two powers or faculties of the mind, he supposes many great errors may be avoided.

* Medicina Mentis, sive Artis Inveniendi Præcepta Generalia: or, what explains the design better, Tantamen Genuinæ Logicæ, ubi disseritur de Methodo detegendi incognitas Veritates. The second edition is corrected and enlarged by the Author.

We next proceed to the Author's method of discovering new truths, wherein he supposes that any one may continually advance to an indeterminate length, without danger of falling into error. And here he advises us first to procure, with great diligence, a stock of all the possible conceptions, which the mind, in the common course of studies and occasions, takes cognizance of. For, from these conceptions, definitions, in his method, are to be immediately formed, then properties to be deduced from these definitions, which properties he calls by the name of axioms; and from the definitions, combined all manner of ways, he discovers secondary truths or theorems, thus making the whole process algebraical.

He determines it to be in the power of men to form scientifical definitions; and, in order to form them justly, advises us to consider the manner wherein the thing to be defined is itself actually formed; or, as he calls it, still in allusion to mathematics, generated; and from this consideration, he directs us to derive the definition. Thus, for example, he defines virtue to be the power which men have of preserving their own nature, according to the laws of just reason, or of procuring to themselves all the real perfections, both of body and mind; or, again, the perfection or melioration of human nature, according to the laws of just reason.

To facilitate this business of forming definitions, he lays down three general rules:—the first is, for reducing things, in thought, under their ultimate kinds or most general conceptions. And these highest mental kinds, or classes, he makes three, relating to things imaginary, mathematical, and physical, under which heads all things that exist may be ranged.

The second rule is, when things are thus reduced under their highest kinds or classes, to observe, either by reason or experience, what things those are which remain continually present in every conception.

The third rule is, that all the formed conceptions be so ordered as to succeed each other, according to what he calls the number of possibilities, or elements; or, according as one thing supposes the existence of another, beginning with the simple cases, and proceeding gradually to the more complex.

The first elements of imaginary things, perceived by the sense, he makes to be fluidity and solidity; the first of the mathematical, he makes to be points, strait lines, and curves; and the first of the physical, matter, motion, and rest, without which nothing farther can be conceived. These rules he explains and illustrates by many examples, especially of the mathematical kind, and then proceeds to shew the way of forming axioms from these genuine definitions, which he supposes to be the elements or first principles of truths. And, by considering these definitions, either simply or comparatively, and in all their elementary relations, he deduces those truths from them which he calls axioms. And thus, by considering the scientifical definitions of a strait line and a circle, or the relations arising from their generations, a large number of axioms may be deduced. For example, from considering the generation of a circle, by the revolution of a strait line about a fixed point, this axiom arises, viz. that the motion is slower towards the centre, and quicker towards the circumference. And so in other cases.

After the requisite definitions are formed and compared together,

the last thing is to combine or join them with each other, so as to constitute what the Author calls theorems, or new truths; for, two or more definitions, or natures, being thus joined together, there may hence arise different natures, or new possibilities, depending upon each other, as we see in compound machines, &c. and this the Author again illustrates with a great variety of geometrical and physical examples. The whole procedure he declares to be the same that is used by the masters of algebra for solving such problems, as at first sight might appear unsolvable by any man of genius. For a problem being proposed, the thing is represented to the eye as if it were already known and discovered; so as clearly to shew what particulars are here joined together, whilst the natures or definitions thereof are already known or actually exhibited. Then each different nature is separately considered, and expressed by a different equation, in the most simple characters possible. And now these several equations are variously compared or combined together, till a single equation thence arises, and includes the natures before expressed by different equations, so as clearly to demonstrate how the question proposed may receive a solution.

The author afterwards shews how his method of discovering truth may be eased; and, in order thereto, first removes the impediments in the way, among the chief whereof he places falsehoods, prejudices, and errors; inquires into their origin; and produces instances thereof, in his three kinds of subjects, viz. imaginary, mathematical, and physical. He accounts those the most subtile and treacherous errors, when imaginary matters are confounded with real or physical ones, which he observes to be done even by the most acute philosophers amongst the moderns, in laying down the principles of nature, and shews how various sects and prejudices have thence arisen and spread themselves.

These false philosophies and reigning prejudices he apprehends may be corrected two ways, viz. first, by exactly distinguishing between the operations of the understanding and those of the imagination; and, secondly, by assisting the understanding in the discovery of truth, with the imagination directed by a good method of investigation. And this help is afforded, (1.) by a just adapting of words to things; (2.) by proper characters for different ideas; (3.) by motions, or moving engines and contrivances, to assist the mind in its operations; and, (4.) by new experiments, which give new conceptions. And by this means he supposes the imagination may be brought to co-operate with the understanding.

The second impediment he makes to be this, that we do not duly regard, nor attentively consider the things already known; and the third, that we too much regard the usefulness of knowledge and discoveries, whereas, he says, we ought to content ourselves with the bare discovery of new truths; otherwise we block up the way to the most useful things of all; for, a very small natural power, which, in the abstract conception, appears of very little significance, may yet prove infinitely useful in its future applications, as in the case of the magnetic needle, printing, gunpowder, &c. for numberless inventions of this kind may be derived from trivial experiments.

The fourth impediment he makes to be a natural indisposition in men, whence they are not always fit to go upon the inquiry after truth; and for this indisposition he proposes several remedies. The fifth impediment is a too long series of investigation, which he endeavours to remove by a proper distribution of the work, and establishing

a proper order. And the sixth impediment, he makes to be this, that the affairs of life often prevent our inquiring after truth, which hindrance he proposes to remove, by directing us to follow our own inclination in pursuits.

In the last place, he comes to deliver the method of discovering unknown truths, with respect (1.) to ourselves, in following our own inclinations; (2.) with respect to those sciences, the knowledge whereof is the most necessary or most pleasing; and, (3.) with respect to natural philosophy, which, when known, is, according to him, the most delightful of all sciences. For, by natural philosophy, he understands a knowledge of the universe, demonstrated, a priori, in exact mathematical order; and confirmed, posteriori, by manifest experiments, sufficient to convince the imagination.

Such is the general plan of the Medicina Mentis, wherein we may observe much sagacity and ingenuity; but, perhaps, when closely examined, the work will appear a little too much influenced by the notion, which the author at first espoused, of fitting the direct algebraical method to universal philosophy, and that he has thus endeavoured to found a universal art of investigation upon one, which, though extremely noble and excellent, is yet limited or confined; or that, at best, his method is not sufficiently general, or fitted for universal practice, but rather formed according to the model of man than the model of nature. It may also, till farther improved, appear to be more mental than practical, and to be better fitted for solving phænomena in the ordinary manner, assigning probable reasons of things, and making all square with the human mind, than to discover such actuating causes as shall enable men to subdue and conquer nature by works, in which light it seems to fall vastly short of the Novum Organum, or Art of Investigating Forms.

But though in this principal view, the Medicina Mentis may not be so useful as the Novum Organum, yet they have a remarkable agreement in numerous other respects, and may be made greatly to assist and promote each other, especially the Medicina Mentis will prove serviceable to the Novum Organum, in the forming of notions; which M. Tschirnhaus terms the forming of definitions. Thus much is certain, that they both deserve to be farther improved and reduced to practice, for the field of nature is so large as to require all the engines and artificial helps that can any way be procured. And if this method of M. Tschirnhaus shall be brought to perfection or commodiously fitted for practice, it will then, perhaps, be found to coincide with the Novum Organum, so as to constitute a part of that general engine, whence it seems in a great measure to have been derived; for, as the Medicina Mentis is the algebra of men, applied to things, so the Novum Organum may be called the algebra of nature, applied to herself.

Among the later philosophers of our own nation, who have endeavoured to improve or find out methods of making new discoveries, the principal seem to be Mr. Boyle, Mr. Locke, Dr. Hooke, and Sir Isaac Newton. Mr. Boyle has given us a particular account of the method he pursued in his philosophical inquiries, which plainly appeared to be formed upon the model of Lord Bacon, and is no other than a loose and imperfect kind of induction, proceeding upon certain tables of inquiry, or general heads of history; for, in every regular inquiry, Mr. Boyle first proposed to himself three kinds of orders, ranks, or

classes, under which he ranged all the particulars relating to the history of his subject, whether it were a body, a quality, an operation, or a process. The first general order, or place, was destined to receive all such titles or heads of inquiry as readily occurred upon the first deliberate view or general survey of the subject, the titles being made sufficiently numerous and comprehensive, and not accommodated to any hypothesis. His titles of the second order were set down, after a careful consideration of the heads of the first, trying the experiments and making the observations there proposed, and after reading authors, conversing with philosophers, and meditating upon the subject, so as thus to have procured a full information with relation to the whole thereof. This set of titles will, of course, be more exact, more full, and better ranged than the first, whence the materials here contained or indicated will, with the proper introduction, alterations in method, connections, transitions, additions, farther directions, &c. begin to form a natural history of the subject, that may be improved from time to time, or from age to age, till it arrives at perfection. Lastly, where the inquiry was difficult, or large, the author thought proper to form a middle order of titles, interposing betwixt the two former; and this by carefully examining and comparing the several particulars ranged under the titles of the first order, so as thus to discover many new directions and heads of inquiry, which being afterwards added to the former may require the whole to be new-moulded, and afford a much more copious and useful set of titles than the first, all which titles are to be filled up, as experiments or observations are made, or the proper informations obtained; but, after all, as many particulars may happen to be omitted, or not be thought of at the proper time, or when they are wanted, and as the history must needs be improvable by after thought and farther knowledge, the Author leaves a place empty by way of appendix to his titles, for receiving the particulars omitted, that belong to some of the titles, but were forgot or overlooked, and another for particulars to be added; under which, such new matter was to be received as might be procured by farther discoveries and improvements made, after the history should be written or published.*

Mr. Locke appears to have designed a kind of familiar explanation and illustration of many aphorisms of the first part of the Novum Organum, in his excellent Essay upon Human Understanding, and again in his posthumous piece concerning the Conduct of the Understanding; but he seems no where to have explained the second part of the Novum Organum, or the Art of Investigating Forms. His philosophical writings are now generally known and read; but, as they tend to the curing of prejudice, preparing the mind, and fitting it for the discovery of truth rather than to open any fresh fountains of science or teach the art of discovery, they need not here be insisted on, especially as they have but little immediate regard to natural philosophy, whence all the sciences should be derived and supplied. And the same character may be understood proportionably of Father Malbranche's Recherche de la Verité.

Dr. Hooke, who was a great master in the art of invention, as appears by his numerous contrivances and discoveries, pursued much the same method as Mr. Boyle. In his piece for improving natural philo-

* See Mr. Boyle's Works, Abridgm. Vol. I. Prelim. Disc. p. 24.

sophy, he seems to have proposed to perfect the design of the Lord Bacon's Novum Organum. And it is great pity that a person so well suited to the work did not proceed farther in it. All he has done towards it is little more than a familiar repetition of what the Lord Bacon had before laid down under the doctrine of idols, helps for the senses, the doctrine of prerogative instances, and the method of collecting a history of nature; though the Doctor has sometimes added apt illustrations, large explanations, and particular improvements.

Had Dr. Hooke finished the piece, according to the scheme he at first proposed, it would doubtless have familiarized the parts of the Novum Organum, which are already extant; and, perhaps, have supplied the rest; but, as it now stands, it is defective in those very parts which are wanting in the Novum Organum. It was, indeed, a posthumous piece; and, perhaps, purposely neglected by the Doctor towards the close of his life, for fear of divulging his mechanical or philosophical algebra, which he seems to have learnt from the Novum Organum, and desired to conceal.*

Sir Isaac Newton appears to have had a very extraordinary method of making discoveries; but, as that great philosopher did not think proper to reveal it, philosophers of an inferior rank can only guess at it, and admire what they do not fully understand. Where the business of investigation depended upon experiments, as particularly in his excellent inquiries about light, he seems first to have imagined, in his mind, how things were, and afterwards contrived his experiments, on purpose to shew whether those things were as he had preconceived them or not, and, according to the information thus obtained, whether from his own experiments and observations, or those of others, he altered and improved his notions, till, after various trials and various amendments, his notions appeared to be just and perfect. And this is a short or mechanical method of induction.

But besides this kind of mechanical method, Sir Isaac Newton had a mathematical one, afforded him by his dexterity in algebra, and his admirable invention of fluxions, which are not to be understood and applied in philosophy, without great sagacity and caution, for, otherwise, they will be apt to mislead. And here this great author has shewn uncommon address, and found the secret of calculating mathematical or mental forces, powers, and motions, and afterwards applying them to natural bodies and natural things. But the attempt is suitable only to a distinguishing and sublime genius, that can let mathematics constantly rule and preside over physics, without corrupting philosophy or rendering it fantastical.

At other times this great philosopher observed the stricter laws of induction, collected the necessary facts, observations, and experiments, and, by contemplating them in his mind, or reasoning upon them, gave the result, with its consequences, as in the theory of the tides, moon, comets, &c. so that he seems to have used all sorts of methods by turns, or to have formed one to himself, compounded of the mechanical, mathematical, and the usual inductive method. So that, if

* See the account of his life prefixed to his posthumous works, p. 4. — See also his method of improving natural philosophy, p. 65; and compare the whole of that Piece, the Preface to his Micrographia, and his own particular inquiries, with the doctrine of the Novum Organum.

this mixed method also were to be prosecuted and brought to the greatest perfection whereof it is capable, it may fall under that still more general one of the Novum Organum.

This Novum Organum, we have seen, is divided by its Author into two general parts, viz. one that is designed to be preparatory or introductory to the other, which is scientifical or doctrinal, so as clearly to deliver a new way of proceeding upon all kinds of inquiries with the greatest advantage to the mind, for acquiring a thorough knowledge of the works of nature, and leading to an unlimited practice for accommodating human life.

The design of the preparatory part is to remove prejudice, procure a fair hearing, and give some tolerable notion of the whole. It may be subdivided into seven smaller parts, or sections, the first whereof endeavours, 1, to awaken the mind, as it were, from its lethargy, and make it see that philosophy and the sciences are so far from being perfected, that, 2, men are hitherto unprovided of the means of forming the sciences; 3, that as knowledge and power constantly go hand in hand, men have but little knowledge, because they produce but few considerable effects; 4, that the common ways of reasoning and contemplating, though so much magnified, are but delusory things, and require much rectification and amendment; 5, that the common logic and syllogism, however useful in common affairs, are of no service in philosophy; 6, that our first notions of things are faulty, and require to be corrected, improved, and verified; 7, that the sure way of discovering truth has not hitherto been tried; 8, that men form vain idols to themselves, instead of discovering the truths of nature; 9, that a more powerful logic than the common, or a kind of engine for the mind, is absolutely required for the service of philosophy; 10, men preposterously delight in a hasty and erroneous way of disputing, judging, and confuting, according to the scanty measure of their own knowledge, and the supposed truth of their own ill-formed notions.

The second section shews the several errors we commit in forming our notions of things, and how detrimental such errors are to the progress of philosophy. It shews that the mind is tinged and infected four several ways, for, 1, men in general have a strange propensity and obstinate property of referring all things to themselves, as if nothing existed otherwise than is represented by their immediate senses, or as if there was nothing in nature but what their senses immediately perceive, whereas the other parts of the universe, as the air, ether, &c. and other creatures, are to be regarded in philosophy as well as man. And here man is shewn, 1, inclined to feign and invent from within himself, instead of searching and discovering; 2, to be extremely liable to prepossession and prejudice, so as with difficulty to remove those false and superstitious notions he has once imbibed, as of astrology, omens, judgements, &c. 3. to be easily moved and led away by those things that affect the imagination more than the reason; 4, to be fond of launching into infinity, and the highest universals, disdaining the intermediate truths, which in practice are more serviceable; 5, to be drenched in the affections of his body, and thence easily turned aside to pride, vanity, false hopes, &c. 6, it is shewn that the human senses, without farther assistance, are of little use in philosophy, though men attribute such great matters to them; and, 7, that men are fond of abstract notions and general theories, at the same time neglecting the due inquiry into

nature and particulars, which alone can shew them what things are. — And these imperfections belong to the species of men or mankind in general.

(2.) The mind is also infected differently, according to the constitution, complexion, bent, or inclination, of each particular person, or according to his education, custom, studies, course of reading, employ, and other accidental matters, whence every man has his own peculiar bias, or, as it were, his own particular glass, tinged to his humour, through which he views every thing. And hence some men doat on mathematics, others on chemistry, others on logic, &c. and accordingly tinge and infect whatever they apply to, with mathematics, chemistry, logic, &c. whereas the true philosopher should not be warped to any particular branch of science, but remain equally affected to them all, as they may all afford their assistance in promoting philosophy; but, in the present state of men and things, some subtile capacities pursue the minute differences of their subject, and making no end of splitting and dividing, as in anatomy, &c. till the mechanical structure or organization of the parts is lost, and others, on the contrary, consider only the wholes, without examining the parts. Some fondly admire the ancients, as Aristotle, Plato, &c. and others some favourite modern philosopher. But, unless the mind be thoroughly convinced of the folly and absurdity of such a procedure, and be brought, by act and habit, to a quite contrary temper, true philosophy cannot be effectually promoted, for the sciences, formed by distempered minds, will partake of the distempers, and accordingly appear trifling, gross, partial, half-faced, distorted, fantastical, &c.

(3.) The third way wherein the mind becomes perverted, is by the abuse or improper use of words, for the philosophical words, in all languages, are commonly false or inadequate marks or signs of things, and by no means convey just and perfect notions. So that men are continually imposed upon, even against their wills, by a wrong imposition of words, which are generally coined by the vulgar; or if by philosophers, it is without taking the requisite pains and care to form notions duly from things, and then give suitable names to these notions. And hence the reasonings, the discourses, and even the writings, of men, are often strangely confused, or but seldom perfectly intelligible, and propagate notions, which men take by consent, without inquiring whether they are just, or how they were formed. But, in order to improve philosophy, it is of great importance to have words suitably adapted, and kept invariably to denote perfect notions, so as to express or convey such notions without delusion or imposition. But no language of this kind can be made, till a set of such notions shall be duly formed from things, which depends upon the use of induction. And as this language and these notions are hitherto in great measure wanting, the mind thus remains unprovided of one very great help for the improvement of philosophy.

(4.) The mind is, again, strangely perverted by fabulous theories and romantic philosophies, which are extremely numerous and still continue to increase. The third section divides them into three general kinds, viz. sophistical, empirical, and superstitious. Sophistical philosophies are those formed upon common or hasty observations and experiments, by a subsequent operation of the mind. Thus Aristotle's philosophy was formed upon common observations, wrought up by his

logic, so as to become sophistical and corrupted; for common observations and obvious experiments are not of themselves fit to build a serviceable philosophy upon, as they by no means shew all the secret motions of nature, and the laws by which things are governed. Nor is the common logic an engine at all suited to deal with experiments, observations, and nature.

Empirical philosophies are those formed upon only a few experiments, though made with great exactness, as Dr. Gilbert's philosophy is formed upon his magnetical experiments, and the philosophy of the chemists upon a few repeated experiments of the furnace, &c. But to form a general philosophy upon a few experiments, must needs appear a childish attempt to those who consider the variety and extent of nature, and the treacherous, faulty, or rash, propensity of the mind, in reasoning from them.

Superstitious philosophies are those where matters of faith and religion are worked up with those of reason and sense, which makes fantastical philosophies and heretical religions. Thus the philosophy of Pythagoras was clogged with gross superstition, and that of Plato with one more dangerous; and thus, of later date, a variety of theories have been given of the earth, from the first book of Genesis, which has had the fate to be differently explained and worked up into opposite systems, according to the different fancies of men or the prevailing philosophies of the times. And thus it appears that scarcely any one has had thoughts of deriving a pure and perfect philosophy from nature, that should be a true model of the world, without any more mixture of logic, mathematics, chemistry, magnetics, &c. than may be found in nature.

In the next place are shewn some particular ways which the mind has of abusing itself, by forming wrong notions of the things that are seen and considered. Thus, upon seeing the changes wrought in bodies by the mechanic arts, in the way of combination and resolution, men are apt to imagine that nature makes use of the same expedients in compounding and separating bodies, whence seem to have sprung the delusory and imperfect notions of the four common elements, as if all bodies were compounded of and resolved into these, hence those called the chemical principles, &c. And thus, from seeing mechanics work with the ruler and compass, seems to have arisen the crude and imperfect notion, that nature operates geometrically, &c. But these and the like notions, being superficial and erroneous, cannot be admitted into philosophy without corrupting it. The same is to be understood of logical, mathematical, and metaphysical notions, rashly introduced and mixed with such as are physical.

Again, the mind is apt to run into two contrary extremes, so as either to be very positive and dogmatical, or else extremely loose and sceptical in philosophy. Thus Aristotle, determining to cut off all future occasion of doubting, called up questions, and resolved them, to shew that all was now settled and determined. But Pyrrho and his followers doubted of every thing. And in this manner men commonly either stop short too soon, and fancy that enough is known already, or continue fluctuating in uncertainties, or else turn aside to amusement, instead of endeavouring to procure an active and serviceable philosophy. And, unless these perverse habits be corrected, no pure philosophy can be obtained.

But, instead of endeavouring to correct these ill habits of the mind, men have the talent to confirm and strengthen them, by corrupt and perverted kinds of proofs and demonstrations, which are generally used instead of the true; for, logical demonstrations wrest the works of nature, to make them square with the thoughts of men; whereas the thoughts of men ought to be submitted and formed according to the works of nature; so that logical demonstrations, applied to physical matters, are only the play of words, or at best deceitful and incompatible. For the unassisted senses are incompetent, notions are ill-formed from their reports, the principles of the sciences can never be justly inferred from a number of instances produced only on one side; and the present method of arguing from principles is erroneous and inconclusive.

The best method of demonstration is shewn to be the demonstration by experience, provided we do not rashly endeavour to judge of other things from it, but proceed therein with great circumspection and rigorous exactness; which method having been little observed, no wonder if true philosophy be but little advanced.

The fourth section proceeds to shew by what signs or marks false theories and philosophies may be discovered, so as to prevent the mind from being imposed upon. And here it is made appear, that the philosophy in vogue over Europe is principally the superficial, professorial, disputatious, and sophistical, philosophy of the Greeks, and chiefly of Aristotle; a philosophy, which, however it may have spread, is little more than logical or verbal, that does not convey such directions as may enable us to perform any thing considerable for the advantage and accommodation of life. And again, it is shewn that the Greeks were masters of little knowledge, especially with regard to the basis and matter of all other knowledge,—natural philosophy.

And here the surest sign whereby to judge of any philosophy, is shewn to be by its fruits or usefulness, in supplying the necessities of mankind, and improving the practical arts whereon the accommodations of life principally depend. But the Greek philosophy having yielded none of these fruits, it is to be accounted barren. And the same judgement is to be made of the chemical and magical philosophies, neither of which have enlarged the human power in any tolerable proportion to their high pretensions. We are not, therefore, to form a judgement of any philosophy from its shew and appearance, the greatness of its authors, the antiquity of its origin, the multitude of its admirers, the reputation it has gained among learned men, nor even from general consent itself; but principally from its use, or the tendency it has to improve the mind, enlarge the human powers, and give us a command over nature.

The fifth section is designed to shew the reasons why the philosophers of all ages have fallen into errors, and made so little improvement in the business of philosophy. These reasons amount to this, (1.) that when a true estimate is made, there has, through the several ages of the world, been very little time well-suited to the cultivation of natural philosophy, which, as must be well remembered, is the foundation of all philosophical knowledge, or the true matter whereof the sciences should be formed: (2.) that, during the times best suited to the study of natural philosophy, little labour has been bestowed thereon, the men of genius and learning having chiefly applied themselves

to morality, civil policy, and religion: (3.) that scarcely any single person applied himself entirely to the study of natural philosophy, which having been always looked upon as a kind of secondary thing, was only consulted occasionally, and, in a perverted manner, made subservient to physic, mathematics, &c.: (4,) that the true end of philosophy has been entirely mistaken, which is to enrich and ennoble human life with useful inventions, new arts, and new powers; whereas philosophers, as they are called, have had views to the raising of sects, aggrandizing their own names, gaining a dominion over men's minds, or some such inferior and pernicious ends. (5,) That wrong ways have been chosen for advancing philosophy, and argument used instead of experiment, reasoning and speculation instead of close observation and genuine induction, and the true method of raising fruitful axioms, and discovering works worthy of mankind, entirely neglected. (6.) That a few ancient philosophers have been obstinately and perversely admired, or almost adored, as men of supernatural abilities, to the shameful neglect of improving the human power; whereas the ancients, living in the younger days of the world, were in many points of experience and knowledge inferior to the moderns. (7.) That a false imagination, as if men were possessed of many excellent arts and perfect sciences, has fatally hindered the improvement of philosophy, whereas the arts and sciences, at present in use, are, in reality, but few and weak, in comparison of what may be discovered by the light of axioms. (8.) That much craft and a kind of imposture has been generally used to make the sciences appear more perfect and complete than they are, whereby many have been deluded. (9.) That much vanity has been shewn by some modern authors, in boasting themselves, and making great promises of extraordinary things for the advantage of mankind; but, shamefully failing in the performance, sober men have hence taken a distaste, and too obstinately believed other practicable things to be of the same stamp. (10.) That men have generally neglected to propose themselves noble and suitable tasks for the improvement of philosophy; and, instead thereof, have indolently determined many sober and rational things to be mere impossibilities, or beyond the reach of art, at the same time greatly over-valuing slender performances. (11.) That religious zeal, bigotry, and superstition, and the school divinity, have, through several ages, been very unfavorable to the improvement of natural philosophy, and checked its progress. (12.) That the common schools, universities, colleges, and societies of learned men, have also generally opposed all new and considerable improvements in knowledge. (13.) That no sufficient rewards have been allowed for inventors and improvers. And, lastly, that sedate and sober men have indulged an untimely despair or entertained a belief that no farther improvements can be made in philosophy. So that, under all these obstacles and discouragements, it is no wonder if very little true philosophy has appeared in the world.

The sixth section, of the first part of the Novum Organum, tends to raise the mind from the languor it may have been thrown into by the melancholy prospect of the former section, and sets before us in a native light what solid reasons there are to expect, that, notwithstanding the obstacles and discouragements above enumerated, a genuine philosophy may be set on foot; and, if men will not remain wanting to themselves, be brought to perfection, and afford all those fruits and advantages that the human

state is capable of affording. And here the author observes, (1.) that, as the art of navigation has discovered new countries, and carries on a correspondence even betwixt the most distant parts of the globe, great opportunities are thus afforded of procuring the necessary informations for enlarging the bounds of knowledge. (2.) That, as we may plainly perceive the errors which the ancient philosophers fell into, and the reasons why they failed in promoting the more serviceable sciences, if the errors they committed are carefully avoided, and a different method to be taken, there are grounds to hope for better success in future. (3.) That, therefore, the art of experimenting and the art of reasoning are to be joined together, or a new art to be formed by a mixture of the two, in order to procure a Sylva, or suitable collection of prepared and well-digested materials for philosophy. (4.) That natural philosophy must be kept pure and uncorrupted with logic, mathematics, and divinity. (5.) That the mind must discharge itself of all prejudice, false notions, phantastical theories, and useless philosophies, and become fit to receive such notions as are just and purely philosophical, without any way corrupting or debasing them. (6.) That a just foundation must be laid for experience, in a history of nature, collected with the greatest exactness, diligence, fidelity, and judgement, so as to make it extensive, or to measure of the universe, without admitting any thing faulty, foreign, or superfluous. (7.) That, in particular, the more leading and informing experiments are to be carefully sought and procured. (8.) That a true order or just method of experimenting be introduced, so that experiments may not remain casual things, but an art of experimenting be formed. (9.) That no inventions, or particular ways of working or combining the materials of philosophy, be trusted to thought and contemplation, but the whole process be exactly written down or described on paper. (10.) That the matters of a pure history of nature be not left in loose particulars, but be regularly digested and brought into tables, according to the nature of every subject, that the understanding may work thereon to the best advantage. (11.) That axioms be formed from these tables, so as to point out new experiments, and thence afford still higher axioms leading to greater works. (12.) That these axioms be formed, not in the way of the ancients, by rising at once from particulars to the most general conclusions, but by careful steps in a safe and guarded manner, so that the axioms thus raised shall not afterwards deceive, but be thoroughly verified, and remain just and pregnant expressions of the laws and facts of nature and art. (13.) That a new method of induction be employed in raising these axioms, viz. such a method, as is suited at once to discover and demonstrate arts and sciences, by investigating the real and internal natures of things. On this new method or art of induction, the author builds his principal hopes of improving philosophy, and to deliver this art was the principal purport of the Novum Organum; the part we are now upon being only introductory thereto. And to give some intimations for perfecting this art, the present Appendix is written. (14.) The last foundation of hope, in the way of forsaking past errors, is this, that natural philosophy may be extended, or made to afford matter to the sciences, and they again be brought back to philosophy, so as to make them centre therein, without mutilating or dismembering the sciences, whilst they, together with natural philosophy, constitute one serviceable corps of knowledge.

(15.) The next fountain of hope for the improvement of knowledge, is the prospect which men may have of future discoveries, if they will put themselves into the proper way of inquiry. For since many discoveries have been hit upon unexpectedly, or by accident; as by the instinct of brutes, &c. without going in quest of them, greater success may be, doubtless, expected from a proper method of inquiry, and the art of experimenting with reason, industry, and sagacity; more especially by the method of induction abovementioned, which is a contrivance for the speedy bringing of new discoveries to light. (16.) Some considerable improvements of philosophy may be also reasonably expected, if the requisite time, expense, and application, shall be used in collecting such a history of nature as was mentioned above, which is a thing that has never hitherto appeared, but may be procured, and is no impossible or impracticable scheme. (17.) And, lastly, though we had less encouragement to hope for success than we have, yet a course of trial and experimenting should be undertaken, because there is thus, at least, a chance of improving philosophy, at the expense of a little labour: whereas, to sit down desponding, or resolved against all trial and attempt, seems unworthy of human nature.

The seventh and last section of this preparatory part of the Novum Organum, is calculated to give some tolerable notion, not only of the design of the second part, but also of the whole; that the nature and use of the new method of induction may be better understood. And here the author declares, that he has no view to found a sect in philosophy, or procure followers; but only to lead men by the hand a little, in order to shew them the way of following nature, and freeing themselves from the necessity of following any philosopher whatever. And in order to prevent all misunderstanding or misconstruction of this his real design, he proceeds to answer the more considerable objections, that might be apt to arise against it, from the prejudices and false notions which men commonly imbibe.

And first because men are naturally impatient, and immediately desire to see the advantages of new undertakings, the author guards his reader against all rash and hasty endeavours after profit and advantage, as what will prove highly pernicious, and tend to prevent the good effects expected. But for those who cannot wait, he leaves them at liberty to use, in their own way, the several helps he has afforded towards the production of considerable works and effects, for he would by no means hinder, but, as much as possible, promote and expedite the discovery of all advantageous arts and works. But till a tolerable history of nature is procured, he judges that no very considerable progress can be made in what he calls the genuine interpretation of nature, or forming of rich axioms, that shall lead to new arts and capital works. Such a history, therefore, himself proposes to procure.

But he apprehends, that several objections will be made to this history, as that it will contain false facts, erroneous experiments, and disagreeable, subtile, vulgar, or abstruse particulars. But all this he shews amounts to little; because (1.) a few errors, and even falsehoods, must necessarily happen in the beginning of a history of nature; and will not prove of any very bad consequence (though they should indeed be cautiously guarded against), for such errors and falsehoods, where but few, are easily discovered and corrected, when axioms come

to be raised, or the interpretation of nature to be entered upon. (2.) Vulgar things being usually as much unknown, with respect to their causes, as things uncommon; such vulgar things should not be rejected, but received into a history of nature. (3.) Disagreeable or sordid matters, such as corruptions, putrefactions, &c. must be here necessarily considered, no less than others; because they give great light into the operations of nature; and things for this design must not be judged of by the rules of elegancy, but according to utility. And (4.) subtile, speculative matters, are not here received for the sake of subtilty and speculation, but only as they afford information, lead to practice, and assist in the interpretation of nature.

The author apprehends it will appear strangely shocking, insolent, and monstrous, that he should at one stroke set aside all the ancient philosophies and all the sciences, and go entirely upon a new scheme of building up philosophy from a different foundation. But he judges that this procedure, when duly considered, will be found more rational, modest, and serviceable, than to have used artful accommodations, and patched up a deceitful system of new and old materials; for as the ancients raised their philosophies upon false notions, or false principles, discovered in an erroneous manner, there was an absolute necessity of beginning the whole work anew. Nor does he think it insolence, if by means of an engine for the mind, or particular helps which the ancients never knew, any one of common abilities should raise a more serviceable structure of philosophy, than they by means of the naked understanding.

To the objection, that the end of all this labour is wrong fixed, as tending to practice and the accommodation of life, and not to the abstract contemplation of truth, which is a much nobler thing; it is answered, that the latter is indeed preferable to the former; but that, in the method proposed, both ends are answered at once, the design being here to give a genuine, a native, and just representation of the world, such as it exists, which is not only the most useful knowledge, but the noblest contemplation; that unites theory and practice together, in their highest degree, and makes them one and the same thing.

To the objection, that perhaps the author's new method is no more than some old one, and therefore not of any extraordinary use; he answers, that the ancients have delivered their method of forming the sciences; which was, by flying immediately from a few particulars to general conclusions; a method very different from the method he proposes, by a rigorous and careful induction: that, in particular, his method does not tend to scepticism, but to a scientifical doubting at first, that the greatest certainties may be afterwards discovered; and that this method regards not any one particular art or science, but all arts and all subjects universally.

But the author hopes that no one will suspect his design is to abolish, and utterly destroy, the arts and sciences at present in use; especially as he has, in his De Augmentis Scientiarum, taken so much pains to improve and shew the way of perfecting them: all he aims at, in this respect, being to convince the mind, that the sciences in vogue are of no use for enlarging the bounds of knowledge, and discovering new arts and practical works: which end his own method is entirely calculated to promote. And yet he does not pretend that this

method of his is absolutely perfect or unimproveable, but, on the contrary, that it will doubtless improve, as new arts are found, or new discoveries made. And thus he concludes the first, or preparatory part of this work.

The second part, as was before observed, is wholly doctrinal or scientifical; and goes directly upon delivering the new art of induction, or method of interpreting nature, in order to form an extensive philosophy; or procure an exact copy of the universe, for perfecting the understanding, and leading to an unlimited practice. And here, as the most excellent things are often the most difficult to obtain, the doctrine delivered will appear somewhat abstruse, till the mind becomes a little acquainted with it; after which all the difficulties vanish, and an agreeable prospect is obtained of a sure and practicable way of procuring, in a moderate time, with the proper assistances, such a philosophy as shall highly improve the state of human nature.

The foundation of the thing is laid in finding a method of increasing the human powers and knowledge, to their greatest possible perfection. And this the author shews may be done by discovering what he, in a new and peculiar sense, calls the forms of things; that is, the laws or powers of nature, by which things physically exist, are generated, or have their effects. And these forms, or laws of nature, he holds to be discoverable by men, and shews how to discover them; in which single point the whole of his new engine centers. There are but two sections finished of this second part: the first whereof lays the foundation of the doctrine of forms, and exemplifies it by a general example, and a set of tables for the purpose; and the second section shews how to shorten inquiries, conducted in this method, by selecting only the more eminent facts and observations, or capital instances, that lead to a full and perfect discovery; without ranging, in an endless manner, through that immense variety of particulars, to be found in nature.

But as it would be a fruitless labour to go upon discovering these forms, without knowing their use when found; the first section of this second part shews, that the end of philosophy is to increase either the knowledge or power of man, so as to enable him to understand the ways and procedure of nature, or else to produce such effects as make for his own advantage; and that to discover forms, is at once to acquire both this knowledge and this power; because by finding the laws of nature, and her ways of producing effects, men will be enabled, so far as their condition allows, to use the same as rules of practice; and thus, in some cases, to equal, regulate, subdue, or even to excel nature by art. So that upon the discovery of forms depends the perfection of philosophy, or the enlargement of the human knowledge and power.

This business of discovering forms being of such infinite importance, the author endeavours to make it as intelligible as its nature will admit, in the present imperfect state of minds and things; and shews, that in effect to discover forms, is the same thing as having some extremely intelligent person, ready at hand, to consult upon all occasions concerning the works of nature, the search after forms being like asking of questions, and the discovery of them like the receiving of answers; so that there is no point of theoretical knowledge, no rules or directions required in practice, but what may as well be had by the

discovery of forms, as if nature herself were to speak, and tell men how she works; and what they must do to imitate, lead, or command her. For to find a form is to find a nature, that shall be equivalent to the nature sought; so as when present or absent, to constitute or abolish that nature respectively: or, to make the conception still plainer, the form of a thing is the effective power, or physical act, by which it exists. Thus, if the nature sought were fluidity, or the means of converting charcoal into a fluid mass; and it be found, by a proper course of inquiry, called the Investigation of Forms, that the form, law, or nature of fluidity, consists in a certain size or smallness of parts, joined with a certain motion; this is finding a nature equivalent to, or convertible with, fluidity: whence men are directed to give this smallness of parts to charcoal, along with the particular motion discovered; upon which the charcoal will put on the nature of fluidity: and accordingly, if charcoal be reduced to powder, and detained in a close vessel in the fire, till its parts are sufficiently agitated, it will have the appearance of a fluid. And this may illustrate, or give some sensible image of the thing under consideration; and shew that both a perfect theory, and a perfect practice, depend upon the discovery of forms.

But as a pernicious custom of leaving experience, and running into abstract speculations has prevailed, the author judges it much the surest method to begin to raise the sciences from practice; or to let the practical part describe and limit the theoretical or contemplative. He, therefore, inquires what are the best practical rules that could be wished for, and finds them afforded by the discovery of forms; so that, on all accounts, the investigation of forms is the first and principal thing that can be gone upon, in order to improve philosophy and perfect the sciences; especially as, at the same time, these forms also afford, according to what was before observed, perfect theoretical axioms, as well as the best practical rules, canons, or precepts.

On this footing, the requisites to practice must be first considered; that is, the means of enlarging the human power, and enabling it to introduce all possible changes upon matter, or produce all possible effects. And here the author shews there are two different kinds of canons or axioms, for producing transmutations or changes, viz. one with regard to bodies, as they are an assemblage or combination of a set of properties; as gold is of a determinate gravity, ductility, &c. and another that depends upon finding the way wherein nature herself proceeds in the generation or production of bodies; as how gold was made in the bowels of the earth, &c.: the first kind of axiom shews how things are made, by introducing a certain set of simple properties into a mass of matter susceptible thereof; and the second directs the way of proceeding by seminal properties, as it were, or beginning with the rudiments of things, and using the same first matter and means that nature herself employs. And where the power of mankind cannot possibly reach to operate, as in the heavens, &c. yet even there the facts of nature may be sought, and her laws and manner of proceeding discovered. The whole process of finding these axioms, and discovering the causes of things, the author calls by the name of the interpretation of nature.

This interpretation of nature has two parts: the first with regard to the forming of axioms from experience, and the second with regard to

the contriving of new experiments from axioms. The first requires proper helps for the mind, or assistances for the sense, the memory, and the reason; and hence, before this interpretation of nature can be exercised to advantage, a just and extensive history of nature and art must be procured; as the first matter out of which axioms are to be framed, forms discovered, and philosophy built.

This history is not to be a rhapsody, or confused collection of all sorts of matters, thrown together on a heap; but to be carefully digested and formed into regular tables, or packets of instances, and prepared parcels of history; as the pillars, the rafters, &c. are made ready for a building. And when such a history shall be procured, the understanding is not to work upon it by means of its own simple natural powers, but is to be assisted by the use of genuine induction; and thus enabled to practise the art of investigating forms.

1. The subject of inquiry being chose; suppose, for example, the form of heat; all the instances wherein heat is found are to be duly collected, and ranged in a particular table, so as to afford a clear view of these instances to the mind. A distinct enumeration must, therefore, be made of all the things that are hot; as the sun's rays, flame, ignited iron, &c. 2. A collection is to be made, and a regular table formed, of those things wherein heat does not reside; but as this might swell the table immoderately, only such things need be mentioned as approach near to the nature of the former, except in the single property of heat, which they are without; such as the rays of the moon, certain corruscations, glow-worms, &c. that afford light, but no heat. And thus the things that are not hot, being placed over against the things that are hot, the mind may distinctly compare the two sorts together. 3. A table must next be formed, to shew the different degrees of heat that are found in different things; or to exhibit, at one view, all the instances of heat, with regard to more and less: beginning with such things as are not sensibly hot to the touch, and proceeding gradually to the most violent heats, as those of volcanos, the burning concave, &c.

These tables ought to be drawn from the history of nature and art, mentioned above, or borrowed from the natural historian, and laid before the philosopher or interpreter of nature; whose office it is to practise the art of induction upon them; so as by comparing them together, both in general and in particular, to find such a nature, law of motion, or action, as being present, exerted, or performed, in any body or portion of matter whatsoever, the nature of heat, or heat itself, shall of necessity be produced therein; and such as when that law, motion, or action, is absent, heat shall be absent, and so come and go with that law, motion, or action perpetually; or attend it in any intermediate degree, according to the exact proportion wherein that law or action is exerted; which is what the author means by the form of heat.

But here, if the mind should of itself directly endeavour, without farther assistance, to discover the forms of things, it would fall upon ill-defined notions, imaginations, guesses, probabilities, and imperfect axioms, instead of true and genuine forms; and thus be far from obtaining the end proposed by this new method. The next step, therefore, is to practise the business of exclusion or rejection, viz. to throw away, or separate in the mind, all those things from the nature

of heat, which do not immediately, and of absolute necessity, belong to it: so that a complete and perfect notion, axiom, or form, that is the pure conception of the true cause, essence, or nature of heat, may remain as a solid and perfect portion of truth behind. And this exclusion, also, is to be performed in the way of a table, wrote down as the former. Hence, as the sun's rays are found to be hot, the superficial notion that heat is peculiar to terrestrial bodies, must be rejected, &c.

And thus the business of induction is begun, but by no means rectified and finished; for as this exclusion, or rejection, is the throwing out of simple natures, or properties, from the nature of heat, a perfect knowledge of simple natures is previously required, before the induction can be completed. But men have not hitherto acquired perfect notions of simple natures, or the simplest properties of things; such as tenuity, fluidity, texture, &c. In the meantime, because truth will easier arise from error than from confusion, the understanding may be permitted, by considering the several tables, to make some attempt towards interpreting nature in the affirmative, or to find out the positive actual form; though without pretending that it is truly and perfectly discovered, till all the preceding tables shall have been perfected; which, as was before observed, depends upon a perfect history of nature; and again, upon using a perfect induction, which is an art that has not hitherto been duly prosecuted, and brought to the necessary degree of perfection.

However, to give an idea of the whole manner of procedure in this business of interpreting nature, when all things shall be properly fitted for the purpose, the author here adds a fifth table; to represent what he calls the first vintage, or dawn of doctrine, from the form of heat. And this table sets to view the process of the mind solely employed, without distraction or interruption, upon the several preceding tables, in order to investigate or discover the form of heat. The result of the whole process amounts to this; that heat is an expansive, bridled motion, struggling in the small particles of bodies: which is a summary expression, or axiom, describing the form of heat, so far as could be derived from the imperfect tables, and the imperfect art of induction here employed. And with this idea of the whole, the author concludes the first section of the second part of the Novum Organum.

In the second section, the author proceeds to perfect the art of discovering forms, or to shew the manner of framing an induction, that shall conclude as justly in philosophy, as syllogism does in logic, or demonstration in mathematics. Accordingly, he here directly treats of prerogative instances, or the way of procuring proper collections of such facts, observations, and experiments, as are best fitted to enter the three tables of view, corresponding to the three first above-mentioned; so that a few of these instances may answer the purpose of many, shorten the business of search and inquiry, and afford a prepared and proper matter for induction, in all kinds of subjects.

And of these instances, he makes twenty-seven different kinds, viz. 1. Such as exhibit the nature inquired after, in things that agree with, or differ from others, in respect to that nature only. 2. Instances wherein the nature sought, appears in a state of generation or destruction. 3. Those wherein the nature inquired after stands alone, in a high degree of perfection or predominancy. 4. Such as shew the

thing inquired after, in its lowest state, weakest virtue, or first rudiments. 5. Such as exhibit the nature inquired after, in the way of a lesser form. 6. Such as shew a likeness and relation in the concrete, so as to help in uniting nature. 7. Such as shew bodies in the concrete, as it were out of their course, or broken in nature. 8. Errors of nature, things monstrous, extraordinary, or out of the course of nature. 9. Bodies consisting of two different natures, or double species. 10. The most perfect works of men in every kind. 11. Instances wherein the nature sought, is either constantly present or constantly absent. 12. Instances that shew the limits of nature, or the bounds betwixt existence and non-existence in all subjects. 13. Such as mix and join natures, supposed to be incompatible or heterogeneous. 14. Such as shew an inviolable conjunction of one nature to another, and the separable alliance of others. 15. Such as shew the separation of natures that frequently meet. 16. Such as assist the actions of the senses, particularly the sight. 17. Such as bring those things to the senses, that did not appear before. 18. Such as discover the motions of nature, connected or gradually continued. 19. Such as afford information, where the senses fail. 20. Such as excite the attention, and hint the subtilty of nature. 21. Such as measure the powers and virtues of things by space. 22. Such as measure the powers of nature by time. 23. Such as shew in what proportion, quantity of body contributes to quantity of virtue. 24. Such as shew the prevalency or subjection of virtues to one another, under which come all the species of motion or active powers. 25. Such as point out advantages and conveniences for mankind. 26. Such as regard things of common occurrence, and therefore save the trouble of new demonstrations; under which come the several ways of practice, or means of operation. And, 27. Such instances as shew that a small quantity of matter, or an apparently small efficient, may have a great effect.

This doctrine of prerogative instances is treated with care, and illustrated with a suitable variety of examples, that open the way to inquiries of all kinds, and lead to the improvement of all the parts of philosophy; so as to shew, in a summary view, what is already known in numerous subjects, and direct a farther prosecution; at the same time that the author is carrying on his own particular design of perfecting the art of induction, and laying down precepts, and giving directions for the execution of the remaining parts of his work. And here ends all that is left us of the Novum Organum.

It is extremely to be regretted that the author did not finish this piece; of which it is evident he had the complete idea, with its almost infinite train of uses. But there being nothing at that time extant, which could, in any tolerable degree, afford the necessary instances for the tables of view, he thought it incumbent upon him to set an example, at least, of the manner of procuring them, as he did in his Sylva Sylvarum; and afterwards digested and fashioned many of them into particular tables, in his History of Winds, History of Life and Death, &c.

He had proposed to deliver the remaining parts of this Organum under the following heads, viz. 1. the helps of induction; 2. the rectification of induction; 3. the method of varying inquiries; 4. the prerogative natures for inquiry; 5. the limits of inquiry; 6. the reduction

of inquiries to practice; 7. the preliminaries to inquiry; and, 8. the ascending and descending scale of axioms.* It might, perhaps, be of some utility, briefly to go over these several heads, so as to indicate a little of the manner wherein it may be conjectured, from his other writings, the author proposed to treat them; and, at the same time, refer the reader to those parts of his own, and other works, where farther light and assistance may be procured towards finishing the whole.

(1.) The first thing in order, after the doctrine of prerogative instances, was to lay down the helps of induction, under which it should seem that the author proposed to deliver, 1. the way of procuring a genuine history of nature and art, as the basis or matter of induction;† 2. to explain the manner wherein this matter might occasionally be reduced into regular tables of view, according to the nature of each subject; 3. to shew the order or method wherein the mind is to consider the instances contained in these tables, both separately and comparatively, or collectively, in order to discover the causes of the thing inquired after, and deduce the axioms for directing new experiments; 4. how these tables of view are afterwards to be improved, or made more full or comprehensive, and ranged anew, so as to exhibit all the particulars in their most natural order, and afford still greater assistance to the mind, in forming more just and perfect conceptions, notions, and axioms; and, 5. the several ways that might be contrived for helping or improving the senses, the memory, and the reason, in order to the forming a more perfect induction.‡

(2.) The rectification of induction stands next in order, by which appears to be meant the making a due exclusion, or rejection, of all those simple natures or properties, that do not essentially contribute in constituting the form of a thing; so that, after such an exclusion is completely made, the pure form shall remain behind, unattended with any thing more than is absolutely necessary, or essential to it; that is, a perfect notion of the essence, or constituent cause of the thing, will be obtained, according to what was mentioned above.

The business of rectifying induction will, therefore, require, 1. a previous knowledge of simple natures, or a set of just and philosophical notions; and, 2. the way of contriving and making certain experiments, or trials, for producing certain works, that shall verify and confirm the truth of induction, by shewing that if men operate according to such rules as are afforded by the axioms, or forms discovered by induction, they may produce the works and effects thus pointed out, which are such as could not be otherwise scientifically produced by men.

The way of forming these notions, is by the use of induction itself, and requires an entire extirpation of all false theories, idols, and vain imaginations, that the mind may become perfectly equable, and disposed to receive these genuine notions,§ which are not to be made

* See Part II. Aph. 21.

† See Dr. Hook's Method of Improving Philosophy, p. 18, 33, and Mr. Boyle's Works.

‡ Ibid, p. 12, 18, 34, 42, and M. Tschirnhaus's Medicina Mentis, p. 182, 211, &c. 2d edit.

§ Ibid, p. 9, and M. Tschirnhaus's Medicina Mentis, p. 72, 91.

conformable to the sense of man, but in exact agreement to the sense of nature, so as to be scientifical and just expressions of things, as they exist in nature, and not as the mind of itself, from the first information of the sense, is apt to imagine them. And these notions will enable us to make a true induction, as it were, a *priori*.

But the other way of rectifying induction is a *posteriori*, and depends upon this, that when a form, an axiom, or canon, is found, or supposed to be found, by using the tables of view and the method of rejection, the proper experiments are to be contrived for determining whether this form, axiom, or canon, be real, and not imaginary or fictitious. And here the doctrine of prerogative instances is of great service, in indicating the requisite trials, experiments, or works, for this purpose. If the expected effect should in no wise follow, the particulars of the tables were either false or incompetent; for the method, when properly pursued, must needs be infallible. If the effect answer but in part, and no error has been committed in the experiment, then the form, axiom, or canon, must be mended, by going over the induction with more exactness and better helps. If the effect answers to the full, under a due variation of circumstances, and in all trials, a proof will thus be gained of the justness of the procedure, the goodness of the induction, and the validity of the discovery. And these two, it should seem, were the principal ways which the author proposed for rectifying his induction.

(3.) The next head is the Method of varying Inquiries, by which we are to understand not only the suiting of the manner of inquiry to the nature of the subject occasionally, but also the ways of transposing, enlarging, and improving, the parts of an inquiry; both with regard to the matter and method, according as new information and farther light is obtained.

Thus, when the view is to discover axioms or forms, the inquiry must proceed from particulars to generals, or from a variety of apposite instances, disposed in suitable tables, to the axioms they afford, or the form they point out; but when the design is to lay out a work, which itself is a particular thing, we must begin with generals, or the axioms already obtained, and descend, by degrees, to the work required. And, in both these cases, most of the steps that are first taken will remain improvable, as the mind becomes better acquainted with the subject, and the things that relate thereto; till at length the inquiry turns to a perfect scientifical history, where no farther alteration of the method can be made to advantage, nor any thing farther be added, for discovering the form, or directing the work, which was the original subject of the inquiry.*

(4.) The next general head of the second part of the Novum Organum, is the Prerogative Natures for Inquiry; whereby we are to understand the art of choosing those subjects, a few of which may serve instead of many, as in the doctrine of prerogative instances, where the author has shewn how all infinity of search may be cut off, or how, instead of an infinite number of particulars, a few may be selected, that shall more advantageously answer the same end; for the like is to be done in inquiries. So that the design here seems to have

* See Mr. Boyle's Method of Prosecuting Inquiries, Abridg. Vol. I. in init. p. 24, 25.

been to indicate a few capital, or leading inquiries, which being duly prosecuted, should unfold nature as effectually as if all possible inquiries were prosecuted; thus proportioning the business of perfecting philosophy to the shortness and casualties of life. What these inquiries are may be learnt from those which the author directly went upon, and those he intended to have proceeded with;* and in what order these inquiries should be prosecuted, or which should come first, which second, &c. must be determined either according to their utility in life, or the tendency they have to prepare the way, and lead to or facilitate the rest, and perfect the entire body of philosophy.†

(5.) The Limit of Inquiry, or an inventory of all the natures in the universe, is the head that comes next in order; under which, in all probability, the author intended to shew, that the whole scheme of his work was no impossible or infinite thing, but limited and circumscribed within moderate bounds, so as to be executed by men in their present state, without a miracle, by the due exercise of their faculties for a competent time: since nature herself is limited, and since the universe consists but of a certain number of simple natures combined into numerous things, as the letters of the alphabet are into numerous words; whence, if these simple natures were understood, the whole system of things might be easily unravelled.

The principal difficulty seems to lie in the collecting a just and sufficient history of nature and art; for, if this was once procured, the rest would follow almost spontaneously. And yet this history, when soberly and prudently considered, will be found no monstrous or impracticable undertaking, provided the proper expense be allowed, a suitable number of hands be employed, and the true method of doing it be observed.‡ The author has endeavoured to give an epitome of the whole thing, in the compass of a few lines.

(6.) The next general head is, the Reducing of Inquiries to Practice, or making them subservient to human uses. This seems chiefly to regard the conducting of inquiries, where not forms, axioms, or canons, are the things in view, nor even the discovery of experiments; but where works and new arts are to be invented, laid out, and brought into use, for a common benefit and advantage. And the general method of effecting this was above observed to be by proceeding downwards, from general axioms to the particular work proposed.

But besides this, the author intended to shew the method of making general practical tables, for laying out works with the greater ease, and bringing them more speedily to perfection. And in this view it seems to be, that in every inquiry he constantly reserved a particular head,

* See Dr. Hook's Method of Improving Philosophy, p. 18, 70.

† The direction of the Medicina Mentis is here different, as it would have no regard paid to excellence or utility, and nothing to be primarily intended but the simple discovery of truths. See that Work, p. 209, 212.

‡ See Dr. Hook's Method of improving Natural Philosophy, p. 27, 29, 36; but particularly p. 21, where the Doctor has these words; "I have very good reason to believe, that the whole mass of Natural History may be contained in much fewer words than the writings of divers single authors; and the method of using them will be much more easy, and the labour of interpreting or understanding them, if done aright, will be almost as easy, as to unravel a bottom when you begin at the right end."

or table, for receiving the things that more immediately regarded practice and human uses.

Again, besides the method of deriving new arts or works from axioms, there is another more mechanical and facile method of deriving them from former experiments or works themselves; which method, though by no means so safe and certain as the former, may, however, prove of considerable service, especially if it were duly cultivated and improved.

(7.) The next head is Preliminaries to Inquiry; by which it may be conjectured, the author meant not only the getting rid of prejudices and false notions, the consulting one's own genius, disposition, and abilities; but likewise the procuring all necessary assistances for the purpose; and particularly using the artificial armour, or machinery of the mind, so that the mind may act in the highest degree of its powers and faculties.* And under this preparation may be included tables or heads of inquiry, previously drawn up, to direct the mind what particulars it should inquire after; what queries it should make; and what intimations it should observe, with regard to the subsequent business of interpretation, &c.†

(8.) The last general head of the second part of the Novum Organum, is the Ascending and Descending Scale of Axioms; which was touched above. It may be farther added, that the business of inquiry, and the improvement of universal philosophy, depend entirely upon, (1.) forming axioms from particulars by legitimate induction; (2.) verifying these axioms; (3.) raising still nobler and more general axioms from the former, till those of the highest order are obtained, reaching even to the universalities of nature; and, (4.) resolving these sublime axioms again, by sure steps or gradations, into lower axioms, that lead to an unlimited practice, and discover all the arts and works that are wanting to accommodate human life.

And thus the general heads that require to be filled up, for perfecting the design of the Novum Organum, have been briefly spoken to, either in the way of conjecture, or from parallel places of the author; with this view, that persons of leisure, who have been versed in practical as well as speculative philosophy, may be the readier induced to finish a work, wherein the good of mankind so much depends.

* See Dr. Hook's Method of improving Philosophy, p. 12, 18, 42, 64.

† Ibid.

THE END.